PROCEEDINGS

1988 MANITOBA BEEF CATTLE SEMINAR JANUARY 19 - 20

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1988 MANITOBA BEEF CATTLE SEMINAR

January 19, 20

Agricultural Extension Centre
Brandon, Manitoba

True to form, the '88 Beef Seminar has once again come up with an outstanding program of real interest to Manitoba's cattle producers. This year we will take a look at processing, marketing and grading as well as the basics of management. Feature evening speaker is Dr. Bob Church from Calgary. There's the Premier Breeder Awards plus commercial displays. Register early to ensure a place at one of North America's premium livestock events.

TUESDAY, JANUARY 19

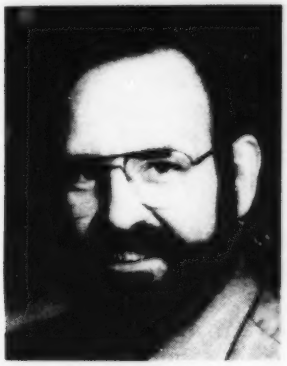
	Morning Chairman — Norm Hemstad, Manitoba Agriculture, Brandon
8:30-10:00	Registration, coffee and visit displays
10:00	***Feeding Bulls — the facts and the myths*** Dr. Mick Price, Chairman, Animal Science Dept., University of Alberta, Edmonton, Alberta
11:00	***How I Manage My Feedlot*** — Dennis Wobeser, Hi-Gain Feedlot, Lloydminster, Saskatchewan
Noon	LUNCH — Ag. Extension Centre
	Afternoon Chairman — Dr. Bob Richmond, Manitoba Agriculture, Winnipeg
1:15	***Consumption and Composition of Red Meat — what's the real cholesterol story? U.S. and Canada — how do our grading procedures compare?*** — Dr. Steve Morgan Jones, Ag. Canada, Lacombe, Alberta
3:00	Coffee and visit displays
3:30	***Trends in the North American Beef Industry*** — Gerry Kaumeyer, President, XL Food Systems, Calgary, Alberta
4:15	Questions and Discussion
4:45	Adjourn
6:00	SUPPER — Ag. Extension Centre
	Evening Chairman — Norm Hemstad
7:30 p.m.	***Premier Breeder Awards***
8:00	***Cows That Pay*** — Dr. Bob Church, Rancher and Cattle Breeder, Geneticist and Associate Dean, Faculty of Medicine, University of Calgary
9:30	Bull session in Ag. Centre Recreation Rm.

WEDNESDAY, JANUARY 20

	Morning Chairman — Dr. Gunther Rahnefeld, Agriculture Canada, Brandon
9:00 a.m.	***Carcass Economics — feedlot returns from breedcross steers*** — Dr. Elwyn Smith, Agriculture Canada, Brandon
10:00	Coffee and visit displays
10:30	***Pasture Weed Control — management's the key*** — Dr. Russell Lorenz, North Dakota State University, Bismarck, N. Dak.
11:30	Questions and Discussion
NOON	LUNCH — Ag. Extension Centre
	Afternoon Chairman —Ray Salmon, Manitoba Agriculture, Teulon
1:30	***Hi-Tensile Fencing — it's better and it's cheaper*** — Bob Rae, Ag. Engineer, Manitoba Agriculture, Brandon
3:00	Adjourn

REGISTRATION FEE — $35.00

Board and room are available at the Ag. Extension Centre



FEEDING BULLS - A MODERN-DAY BEEF INDUSTRY?[1]

- by -

Dr. Mick Price
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CASTRATION - AN ANCIENT PRACTICE

Cattle owners have been castrating young bulls for thousands of years. How they discovered it is unknown, and how they did it is better unasked! We can, however, speculate about why they did it.

WHY WERE BULLS CASTRATED?

My guess is that its main advantage to our ancient forebears was that it made these great beasts manageable. A second advantage would have been that it promoted fattening. In those far off days of unimproved pastures and no winter feeding

Easy Fattening

animals which fattened easily would have a better chance of surviving to a reasonable slaughter weight (several years at least). In addition a fatter carcass would contain more energy (a desperate need in those days) and would last longer since fat would slow down spoilage (rotting) and desiccation.

Selective Breeding

Much later, when man began to practice livestock improvement through selective breeding, castration would have prevented indiscriminate mating, allowing all males, except the chosen few, to run with the herd.

Eating Quality

Undoubtedly ancient man would have noticed that middle-aged steer meat was easier to bite through than middle-aged bull meat, but I somehow doubt if that would be a big deal to him. I don't expect that ancient man was much of a gourmet!

IS IT STILL JUSTIFIED?

So the case for castrating bull calves seems pretty strong. But if we examine those arguments in the context of late twentieth century conditions we find they have less foundation.

MODERN MANAGEMENT

With modern cross-fencing, pens, corrals, chutes and squeezes, livestock management, even at close quarters, is much easier, and even the rankest of

Fat No Longer Desirable

bulls can be contained. Indiscriminate breeding is similarly unlikely to be a problem. Excess fat is no longer required in meat either for energy or for protection of the carcass, and since we typically slaughter cattle for beef at 12-18 months, modern bull meat is pretty well indistinguishable from modern steer meat.

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[1]Paper presented at the Manitoba Beef Cattle Seminar, Brandon. 1988 January 19.

Time to Re-Evaluate

Thus the "classic" reasons for castration no longer apply and we can begin with a clean slate to weigh the pros and cons.

ADVANTAGES OF BULLS

From a straight production point of view bulls are far superior to steers. Until about puberty (weaning) bulls only show small advantages in growth rate over steers - 2 or 3% (though in almost any other industry that would be considered a huge "competitive edge"). However, in the feedlot they typically show a 20-30% growth rate advantage, even over implanted steers. This is accompanied by a 15-25% reduction in feed requirement per unit of gain giving bulls a considerably lower cost of gain than steers.

Feedlot Performance

Grading

These growth advantages carry through to the carcass, it is easier to get an A1 grade using bulls because they fatten more slowly. This means that in a large group of bulls which average an A1 finish few will be B1 or A2. In a similar group of steers (which fatten more quickly) there will be plenty of over- and under-fat carcasses.

Carcass Quality

Bull carcasses are superior to steer carcasses because they have higher cutability (less fat and a higher meat to bone ratio). Some argue that bulls have a lower proportion of meat in the high priced cuts, and this is true. However, because of the difference in cutability the truth is that a 700 lb bull carcass has the same weight of high priced hindquarter meat as a 700 lb steer carcass. And it has more front quarter beef as a free bonus!

Improved Selection of Herd Bulls

An often overlooked advantage of keeping bulls for beef is that it increases the choice of sires for the next generation. With this system every young bull born in the herd, if he has the right stuff (genes) can be saved from the packer and used for breeding.

Cost of Operation

Finally, of course, using bulls avoids the need to castrate. Although it may not be a very costly operation (calves can usually be castrated when they are rounded up for some other reason), it does involve labour, a set back to the calf and the occasional infection and death-loss. And beside that you might cut your finger!!

DISADVANTAGES OF BULLS

In view of the very solid list of advantages to using bulls (above) there must be some pretty solid disadvantages otherwise steers would be museum pieces! They seem to me to fall into two main categories - Behaviour and Market Discrimination.

Management

Bulls are definitely different to manage than steers. Unfortunately they seem similar enough that many people treat them like steers and say they are unmanageable. Two problems commonly arise which are rarely seen among steers: aggressive (dominance) behaviour and homosexuality.

Aggression

Aggression is manifested in threatening, bunting, fighting and riding. Most of this is intended to establish a social hierarchy (even most of the riding is a dominance exhibiting behaviour). Once the bulls know each other this type of behaviour diminishes considerably. Obviously the bigger the group of bulls the longer it takes them to get to know each other. In pens of a hundred or more they will effectively never get to know each other.

Strategies to Minimize Aggressive Behaviour

I'm sure its not beyond the wit of our feedlot managers to find techniques to minimize the consequences of aggression. Some that come to mind are: avoid mixing strange bulls together; best of all feed bull calves that have been raised together in the same herd. Keep lot size to a minimum; certainly the aim should be less than a hundred per pen especially if they are from many different herds. Keep females beyond smelling range. Provide a complex and interesting environment in the pen (e.g. "toys" like tires and unopened bales; escape chutes, etc.). Each of these strategies has a cost, and the individual manager has to decide whether it would pay. The challenge is to find some way to do it profitably!

Homosexuality

While dominance associated riding will eventually diminish as the bulls become familiar with each other, all bull feeders become familiar with the phenomenon of the "sweet-ass" bull. These are a real problem in that they will stand to be ridden. It appears to be true homosexuality, and doesn't diminish much with time. Apart from the damage done to the bull itself it can also cause damage to the pens, and the constant disturbance sets off fights and reduces feed consumption. The only solution to this problem seems to be to pull those bulls out and pen them separately. Some producers in Alberta have told me they put them with the heifers - I offer no guarantees!

MARKET DISCRIMINATION

The second major disadvantage of bulls is market discrimination. This will occur in both feeder and fat markets.

Feeders

For the reasons outlined above no one is interested in a small group of bull calves. They will have to be penned with others and this causes social problems. In addition most feeder-buyers don't

have as much experience buying bull calves and feel uncomfortable trying to value them. A cow/calf producer thinking of raising bull-calves therefore has two main choices: 1. private treaty arrangement with a feeder who guarantees to buy them; 2. retain ownership and either feed them himself or have them custom fed. I increasingly recommend the latter but bank managers sometimes take a dim view of it!

Selling Feeders

Fats

Because of their behavioural differences, bulls need to be handled carefully before slaughter. Cattle which get excessively excited before slaughter tend to give dark, sticky beef (grade Canada B2 and a big discount). Bulls are more likely than steers or heifers to get excited, so they have a reputation for dark-cutting. As a result many packer-buyers will bid bulls down, particularly at auction, because the extra handling increases the possibility of dark cutters. The answer, of course, is to sell them on a carcass weight and grade basis, and to take a very close interest in how the bulls are loaded, trucked to the plant and unloaded. At the plant they should go directly to the knocking box. Good handling will eliminate dark cutters.

Selling Fats

CONCLUDING PLATITUDES

The use of bulls in place of steers offers huge advantages in terms of efficient gain and superior carcasses. The main disadvantage seems to be that the management problems haven't been fully solved. This is the role of industry, and the feeders who find inexpensive solutions to this problem are looking at solid financial rewards.

HOW I MANAGE MY FEEDLOT

Dennis Wobeser
HI-GAIN FEEDLOT LTD.
Lloydminster, Alberta

Outline of Hi-Gain's start up 25 years ago and some of the highlights leading up to present day position.

- Introduction of Silage
- Use of manure on fields
- Introduction of high moisture barley

Main items that are important:

1) PURCHASING - How, when, what kind of cattle best suit our program and the market

   - Discussion of changing types and breeds of cattle to fit the grade standards and new pricing structure i.e. A2 discounts. We must have cattle that can put on a lot of weight and still not be too fat.

2) PROCESSING ON ARRIVAL

   - Yearlings are not real critical while calves are very critical
   - Constant monitoring of morbidity and mortality rate
   - Use of the thermometer has been the best innovation we have made

3) FEEDING PROGRAMS

   - All geared to producing beef at the lowest possible cost using feed stuffs which can be most economically grown on our own land base.

4) MARKETING

   - How we endeavor to offer our cattle to the most potential buyers and still retain control of the actual sale and sale conditions.

5) RISK MANAGEMENT

   - Is the key to the future of the cattle feeding industry

     a) Custom Feeding
     b) Equity Financing
     c) Tripartite Stabilization
     d) Futures Market
     e) Forward Contracting

CONSUMPTION AND COMPOSITION OF RED MEATS: What is the real story? US AND CANADA: How do our grading procedures compare?

S.D.M. Jones
Agriculture Canada, Research Station,
Lacombe, ALberta. T0C 1S0.

My presentation will cover two main areas: the composition of red meats which relates to the diet/health debate and the relationships of the Canadian grading system with the one in the US. Both of these issues are important to the beef cattle industry.

Consumption of Beef

The consumption of meat is usually quoted in terms of its carcass disappearance. The total amount of carcass weight produced in a year less that in storage and adjusted for imports and exports represents the amount of carcass which disappears in Canada. The figure for beef disappearance amounts to about 38 kg or 84 lbs in 1986. Unfortunately, many people have often assumed that the carcass disappearance figures relate to actual consumption by consumers on the dinner plate. By the time a beef carcass reaches the retail store or for food service usage a considerable amount of processing has been conducted. This involves the removal of bone and fat with the result that there is about a 27% loss of weight from the original weight of the carcass. Once the meat is cooked there is a further average loss of about 25%. Actual consumption is therefore close to about 19 kg or approximately half of that provided by the carcass disappearance data. On a daily basis this amounts to about 55 gms (or 2 oz) of beef per day. The Canada Food Guide recommends 2 servings (180 gms) of meat a day, and it can thus be concluded that our consumption of beef is modest rather than excessive.

Composition of Beef

Over the last 30 years there has been a large number of medical trials both in the laboratory and in the field which have related diet to human health. These factors have implicated cholesterol and saturated fat as being risk factors in the development of heart disease and certain forms of cancer. Nutritional data for beef until recently has been out of date with the result that beef has been labelled as a product that is high in both fat and cholesterol. Consequently, advice has generally been passed onto consumers that beef should be limited in diets to reduce the overall consumption of fat and cholesterol. This has had a major influence on the image of beef as a healthy food and no doubt influenced consumer buying preferences. Survey information collected in the US in 1985 showed that 68% of all food shoppers agreed that it was important to limit fat intake, 45% to avoid foods high in cholesterol and 53% were concerned about salt in foods. These concerns about diet and health resulted in 26% of food shoppers declaring that they had reduced meat purchases for health reasons. However, in Canada the latest consumer surveys conducted by the Beef Information

Centre show that the number of consumers serving less meals with beef has declined from 51% in 1982 to 25% in 1987. This does provide a measure of the success of beef promotion which has concentrated on the message that today's beef is lean and healthy.

In recent years, several studies have been conducted to update nutrient data for red meats. These studies were necessary since nutrient data from the US was exclusively used by health professionals to give nutritional advice. The old US data was collected over 30 years ago and there is plenty of evidence to show that the fatness of beef has been substantially reduced over this period of time (Table 1) For example, since 1973 the percentage of A1 carcasses in the A grade has increased from 39.8% to 58.2% in 1985. In addition, it has been known for some time that beef produced in Canada is considerably leaner than its American counterpart.

Studies conducted at the University of Guelph and by Agriculture Canada have examined the fat content for a range in beef retail cuts. The results of these studies have shown that trimmed lean portions of cooked beef contain modest amounts of fat which compare quite favourably with chicken and fish recognized by most consumers as low in fat. Table 2 shows a comparison of beef and chicken prepared from data in the Canadian Nutrient File. The overall conclusion would be that there is really no difference between beef and chicken in terms of fat content. These findings are indeed good news for beef producers and should be used to their fullest extent to transfer this information to consumers.

There has also been a general misunderstanding concerning cholesterol in meat. Cholesterol is part of the structure of the cells in human and animal bodies. Our bodies make a continual supply of cholesterol whether we eat animal products or not. However, for some reason cholesterol has been associated with fat and since beef has been considered to be a fat meat until relatively recently, beef has also been regarded as high in cholesterol. The results of the recent Agriculture Canada trial showed that the amount of cholesterol per meat serving was less from beef than it was for a similar portion of chicken (Table 3). However, my own interpretation is that all lean meats have a modest quantity of cholesterol which fit in very well with the dietary goals provided by health professionals.

Much has therefore been done in the last 5 years to show that today's beef is lean and has a place in a healthy lifestyle. However, there are still many people who have not received this message, and promotion of beef based on its leanness will continue to represent worthwhile spending of producer's dollars.

Canada and US Grading Relationships

The primary purpose of any grading or classification system is to place carcasses with similar characteristics into 1 grade or class. The two components in most grading systems are an estimate of meat quality and an estimate of meat yield. In Canada, a new system of carcass grading was introduced in 1972. This system identified subcutaneous or external fatness as one of

the primary determinants of carcass grade. Carcasses now with a minimum cover of 4 mm of fat qualify for the A grade. Best prices are paid for carcasses in the 650-720 lb range with 4-9mm of fat. In the US there are separate grades for quality and meat yield. The quality grade is influenced by carcass maturity and the degree of marbling fat found at the rib eye muscle between the 12/13 th ribs. Carcasses with only traces of marbling are graded STANDARD, those with slight marbling SELECT, and those with SMALL marbling or more are graded CHOICE. Following the application of the quality grade, the carcass is then yield graded on a 1 to 5 scoring system analagous to our 4 point system. Thus, yield grade 1 would indicate a high meat percentage whereas yield grade 5 would indicate an extremely fat carcass. Although there are some similarities between the two systems, there is little information to show the corresponding equivalent of Canadian to US grades.

A study was conducted at Lacombe and funded by Farming for the Future in 1986/87 to examine the relationships between US and Canadian grading procedures. A data base of some 3900 carcasses had been collected over a 15 year period of time which had been officially graded according to Canadian standards, and contained the necessary carcass data to place a US grade on the same carcasses. The cattle used were a variety of types generated through the use of European bulls (Charolais, Simmental, Limousin, Chianina, Gelbvieh) crossed onto British type cows with various percentages of European breeding (25-100%). The slaughter endpoint for all cattle was approximately 8 mm of subcutaneous fat.

The relationship between Canadian grade and US quality grade is shown in Table 4. Approximately 75% of the carcasses that graded A1 had sufficient marbling (small) to qualify for US low choice. For Canada A2 the corresponding frequency was 90%. Most carcasses only achieved the minimum marbling requirements for low choice so the conclusion that most A1 carcasses would achieve choice grades should be treated with some caution.

The A1 carcasses which recorded small marbling were then categorized into an American yield grade. The results showed that 29% were yield grade 1, 47% yield grade 2 and 19% yield grade 3. This contrasts with the current frequency of US choice yield grades of 4% yield grade 1, 41% yield grade 2 and 50% yield grade 3. Therefore, Canadian carcasses have a potential advantage in terms of lean meat yield, which amounts to 1 yield grade point or about 3% lean meat. There is a moving trend in the US towards leaner beef. It is currently estimated that only 70% of market cattle are graded, the other 30% not qualifying for choice because of insufficient marbling and marketed as no rolls. There is clearly a market for Canadian style beef particularly in the Pacific North West and in California where recent consumer surveys have established that consumers cannot tell the difference between choice and select grades of beef.

Conclusions

The nutritional data on beef shows that it compares very favourably with protein alternatives such as chicken and fish. However, there are still many consumers which do not know the

real facts about beef and promotion dollars should continue to be spent on improving the image of beef.

There are clear relationships between the US and Canadian grading systems. At the present time there is no major pressure to establish a reciprocal grading arrangement with the US so that carcasses for export could be graded with a US grade stamp in Canada. Economic analysis suggests at the present time that a grading agreement would benefit Western Canada to a rather modest extent, but this would be offset by greater losses in the beef market to Eastern Canadian beef processors.

Table 1. Frequency (%) of marketings in the A grade

Grade	1973	1983	1985
A1	39.8	55.6	58.2
A2	41.7	36.0	34.2
A3	14.1	6.9	6.4
A4	4.4	1.5	1.2

Agriculture Canada 1985

Table 2. Comparison of fat in chicken and beef

Cut	g Fat/90 g serving
Top round steak, broiled	3.1
Sirloin steak, broiled	6.1
Chicken, breast roasted (no skin)	3.1
Chicken, roasted (no skin)	5.9

Canadian Nutrient File 1987

Table 3. Comparison of beef with chicken and fish for cholesterol

	mg Cholesterol/90 g serving
Beef	66
Chicken	76
Cod	73
Shrimp	135

Canadian Nutrient File 1987

Table 4. Relationship between Canadian grades and U.S. quality grades: Percentage of US quality grades.

	Canadian Grade		
	A1	A2	A3
U.S. Quality Grade			
Choice	74.4	89.2	95.8
Select	22.1	9.2	4.2
Standard	3.5	1.6	0.0

TRENDS IN THE NORTH AMERICAN BEEF INDUSTRY

G.E. Kaumeyer
President & C.E.O.
XL Food Systems Ltd.

In order to put my remarks in perspective I would first of all like to give you some insight into the type of operation with which I am involved. At the very outset I would like to emphasize that many of the conclusions reached, that make sense in our environment, may not have application elsewhere. I will elaborate on this point somewhat later.

XL FOOD SYSTEMS LTD., the company that I head up, is the only totally integrated beef production operation in Canada. It has evolved from one of Alberta's early homesteads into the only totally integrated beef production operation in Canada. Our operations involve a ranching and farming operation utilizing approximately 77,000 acres of land. The ranching operation runs a 1,500 cow herd under a cross-breeding program on the rougher part of the land holdings. The balance of the land is utilized with some center pivot sprinklers to produce grain and forage for the livestock and feedlot operations. The feedlot operation consists of a 10,000 head backgrounding lot in which calves and light feeders are grown to approximately 800 pounds before being transferred to a 15,000 head finishing lot in which cattle are fattened for slaughter. The company also owns three beef processing plants all located in Calgary, Alberta. The slaughter plant, with a capacity of approximately 5,000 head per week, processes fed cattle for the wholesale carcass market and for the company's boxed beef plant, where carcasses are further converted into

vacuum packed subprimals for the retail and food service trades. The third plant is a boning operation producing boneless beef for the retail ground beef market and further processing customers.

This system of integration took place over a number of years in response to two basic factors. Number one, was a desire to control, to a large extent, the product through the processing system, to ensure high quality. The second, and perhaps more important, was an attempt to minimize the fact that the pricing mechanism in the North American cattle industry is based on averages. Prices of live cattle and the product are based on the average values, not on the value of each individual animal, carcass or cut. In effect, the cow-calf producer sells his calves on an average value of the entire crop, the feedlot on the average value of a pen of cattle, the packer, on the average value of the carcasses or of his boxed product, and the retailer on the average retail yield of the product he purchases. It was our perception in building the company that the only way to eliminate this averaging price process was to own the product at all stages of production.

Having provided some background on my company, I would now like to provde some general observations about the North American beef market. I think it is fair to say that the attitude of the industry towards its customers has changed. There is no longer the perception that beef is such a preferred product by consumers that all you have to do is make it available and they will consume all that you produce.

In talking about changes in consumer demand it is very easy to quote per capita consumption figures.

Unfortunately, changes in consumption are not the same as changes in demand. Various studies of meat demand have concluded that some type of change in beef preferences occurred in the late 1970's. Consumers became less willing to buy more beef when beef prices fell, less willing to spend additional income on additional beef consumption, and more willing to substitute chicken for beef.

In trying to isolate the reasons for the change in demand for beef a number of factors are frequently cited:

- health concerns about the fat and cholesterol in red meat
- the increasing proportion of the population over 65
- changes in the distribution of income growth since 1978
- the changing structure of American and Canadian households and the increasing particpation of women in the paid work force

As a result of the changes in preference for beef and its effect on demand, almost all segments of the industry are now spending considerable money and time in trying to better understand the needs of the consumer. Producer groups in both Canada and the United States are spending large sums of money raised through a check-off system on consumer research and product advertising. Packers and processors are spending time and money on new product development--products that better suit today's housewife and new types of packaging. Retailers, particularly the large supermarket chains, have undertaken an extensive study of the beef market to better understand how to attack it.

The end result of this sudden concern for the consumer is a number of very important conclusions.

(1) An awareness that the beef market has become segmented in recent years with each segment such as the hotel and restaurant trade, the fast food trade, the health conscious, the YUPPY, (young, urban, professional), trade--each with its own special requirements. No single product line will completely meet all consumers' needs.

(2) An awareness that convenience and freshness are two key consumer requirements that the industry must address in preparing for the future.

(3) Fat is obscene to consumers--thus it is essential to trim it off or, more logically, don't produce it in the first place.

(4) In order to remove beef from the commodity arena it is important to develop branded beef products that would create customer loyalty; preferably prepared in such a way as to go directly into the meatcase of the retailer.

At this point, a logical reaction to my comments might very well be, "Very interesting, but what application does this have to a breeder of beef cattle?" I would suggest that these developments will have some very profound affects on our industry. With the move to branded beef products, (the two programs in the United States that have received most publicity are the Excel Program of the Excel Corporation, and the Hitch Ranch Premium Beef program), there becomes an absolute necessity for consistent quality and reliability. To ensure that their products have

consistent quality will lead processors to establish production specifications that will, in all probability, include breeding, feeding and management guidelines. In addition, there will be price incentives to produce genetically superior animals that meet the standards of carcass desirability. In other words, the packer-processor will pay a premium for cattle that meet his specifications and probably apply bigger discounts for those cattle that do not.

As an example of this trend, one large U.S. packer announced, a short time ago, that they were going to define a "Super Breed" that would describe the ideal slaughter animal for their program. They very quickly ran into so much political flak from various breed associations that they dropped the matter but they continue to encourage the production of what might be called "specification cattle".

Several years ago there were a number of programs in Canada which attempted much the same approach. Much of this interest was generated by the introduction into Canada, almost twenty years ago, of the so-called exotic breeds from France, Switzerland, Germany and Austria.

In our own operation, not knowing which of the new breeds would work best under our ranch conditions, we undertook a three year program under which we AI'd 1,000 range cows on a random basis to Simmental, Charolais, Limousin and Maine Angus using Hereford cleanup bulls. Each year we separated the calf crop into the different cross bred groups and separately fed out the steers and grew out the heifers for breeding as yearlings. Our cow herd, I should mention, was predominately Hereford and Hereford-Red Angus cross bred cows. Our results indicated that from a

rate of gain and grading point of view there was little difference between the Simmental and Charolais cross bred steers. The Maine Angus steers were somewhat inconsistent and the Limousin steers weighed approximately 150 pounds less than the Simmental or Charolais crosses and took a month longer to reach a suitable grade.

Our experience with breeding of yearling F1 heifers indicated that the Simmental F1 had reasonable conception while the Limousin and Maine Angus didn't mature early enough to ensure reasonable conception under such conditions. This research, which again I emphasize relates to our particular conditions under which our cattle range receives an average of 10-12 inches of rain annually, where the carrying capacity is basically one cow to 40 acres, convinced us to utilize Simmental bulls in developing a herd of F1 cows on which we used Charolais bulls for a three way cross. The resulting calves proved very satisfactory in our feedlot operations.

Another somewhat more scientific research program was carried out by Agriculture Canada in which they tested cross breds under two dramatically different prairie regions. They used 10 types of cows that were first crosses between a British breed and the most popular imports. The herd was split between pastures at a place called Manyberries, a semi-arid short grass region in Southeastern Alberta, and the Brandon region in Southwestern Manitoba, where cultivated pastures were the norm. The study found that while the high milking crossbreds performed well at Brandon, at Manyberries they had reduced conception rates, and higher calf mortality. This led many producers to utilize one quarter Simmentals as a range bred cow to provide the desired milking ability with the increased ability to weather an adverse environment.

Another breed to have tracts somewhat of a mixed blessing were the Limousin which sired calves weighing less at birth and produced great carcasses, but which at both locations were found to have a 25% slower growth rate than their exotic counterparts.

I think the moral of this story is that there is no such thing as a "Super Breed" because climatic conditions, management, market requirements, all vary so greatly that each producer has to establish what works best for his circumstances.

Another result of changing trends in the industry relates to consumers dislike for fat. In Canada our government beef grading system was changed in 1972 to recognize this trend so that the pricing mechanism paid an incentive, if you like, for carcasses with a minimum of back fat. In the United States they have been struggling with their grading system but to date have not been able to bring about a change. As a result, their system still pays a premium for carcasses that carry excess back fat which necessitates trimming to one quarter of an inch either by the packer or retailer. Obviously, this is a very wasteful system and has brought about a trend under which retailers are selling so-called "No-Roll" or ungraded beef which has less back fat. This, however, does produce the possibility of reduced quality.

One last result of the changing trends and attitudes regarding the beef industry is the emergence of co-operative programs between retailer and packer-processor and sometimes the producer, in developing products for "niche" markets. An example of this development is a program we have been

involved in with one of Canada's largest retail chains. This chain, after considerable research, established that a "niche" market existed for a beef product that could be guaranteed free of all chemical additives, growth stimulants, antibiotics, etc. They approached us to see if we could supply them with 200 carcasses a week, 52 weeks a year, that would meet these rigid specifications. Thanks to the integrated nature of our operations, after considerable planning, we were able to develop a management program with all the necessary tests, etc. to ensure that we could perform. There is every indication that consumers are more than satisfied with the product and prepared to pay a premium for it, the retailer feels the program will increase his overall beef sales and as producers and packers, we are finding the program to be profitable.

In summary, there is no doubt in my mind that current trends in the beef industry will provide many exciting opportunities for producers. Recent consumer research, more factual nutritional information, new product development, all will reverse the trend to reduced beef consumption. As cattle breeders we have to become more sophisticated to take advantage of the trend to "specification feeding" and the premium prices it will provide.

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COWS THAT PAY!

INTRODUCTION

I would like to discuss some options for raising cows. I am a producer of grass marketed through cattle. High-tech and low-tech cows represent both ends of the spectrum and each can be profitable in the right circumstances. Most of you will utilize some of each approach depending upon your particular operation. I am an absolute believer in the adage that there is a "horse for every course". How you put your geography, climate, management, financing and experience together are unique to your operation. You don't give a damn what the Jones' down the road are doing or how!

Things change and the impact may not be anticipated. The last couple of years, I've developed some extra inches around my middle. My kids give me a hard time and my wife a knowing pat! The cause is not that I am eating more, but big round bales. I don't have to throw bales anymore! I have a front end loader that does it. The impact shows up right here around my waist. Management changes can impact in areas which at first glance don't seem related. This talk will attempt to look at low-tech and high-tech impact on the cow business.

I am involved in both the high and low-tech cattle business. I drive from a high-tech laboratory operation back home to the ranch, which is an old-time, low input, outfit. In both cases, there is profit to be made but with very different management inputs.

I'd like to relate a little of how both operate. I'm not saying I have the answers. I'm simply saying that in the foothills of southern Alberta, in the high

country of Wyoming, in Western and Northern Australia. my approach seems to work. I have identified what my markets are and what the consumer wants! I try to produce beef that the consumer wants.

THE PRODUCER LOST THE CONSUMER WITH THE ADVENT OF BOXED BEEF!

Years ago, I was really disturbed by the fact that I was never served beef when I went out for dinner in city homes. That started me thinking - Why? I intended to go back and take an active role in our family cattle operation but I was concerned about the possibility of no-one wanting to buy beef. I kept score when we went out to dinner in the city. I asked every hostess why she hadn't served beef? She said she had been embarrassed once! She came from a family where a roast was the way to treat company. Roasts were served for special dinners. One roast was so tough, a hunting knife was needed to cut it and it had no flavour. An embarrassed hostess vowed never again! So we were served lasagna, lamb, poultry, etc. In a period of 9 years of dining with urban hostesses, we were served beef once!

Canadian home consumed beef consumption is dropping. Baby boomers are turning away from beef as presented in most supermarkets. The competition is revving up as well. All you have to do is look at the meat counter of any store here in Brandon and compare it to 10 years ago. How little space is devoted to fresh beef, compared to chicken or specialty meats. What this tells me is that the retailer doesn't care what he has on that shelf as long as the dollar turnover is there per foot of shelf. In Saskatchewan and Alberta, our quality product is shipped to Montreal or sold to the restaurant trade. The quality beef raised in western Canada, is found in restaurants, Montreal and Toronto supermarkets.

Fast convenient products are in demand hence the development of precut branded and preportioned beef. To meet this market we must utilize our resources to produce a product that sells. Our basic resources are cows and grass in different

combinations. Our cows are competing against the rest of the world. Our market is for ground beef, steak, veal or roast beef, but we don't communicate with the consumer to know. In the past, packers dictated to both the producer and consumer! There are misconceptions about beef that worry consumer and producer. A lot of people want a lean, tender product, which is convenient to prepare and reliable.

Consumer demand is there but not always serviced. When the liner pulls away from the ranch with your cattle, do you say goodbye! Do you ask if the consumer was was getting the beef they wanted? In years gone by you took your product to the market and interacted directly with the consumer. There are now options to the bottleneck created by big packers and their boxed beef.

REALIZED MANAGEMENT IS THE KEY TO PROFIT!

The second point I want to make, is that you can make and lose money in the cow business in different ways. The key is your management profile. I call it the profitability chain. This is a little common sense every one of you uses every day. This chain is only as strong as the weakest link: lack of finance, geography, market, management tools, etc. leads to realized management. Realized management is what you do, not what you think you do. The dollars at the bottom line reflect your realized management. Some factors are beyond your control so spend less time on them than others which you can change.

Let me tell you a little story. A young fellow I know had lots of hope for his farming operation. A few years ago he quit feeding hogs. He got rid of his cow herd and let his fences down. He was going to become a grain farmer with the status of farming to the roadside from April to September. When grain prices dropped, he couldn't meet his cash demands. I suggested he should feed a few cattle with the 65,000 bushels of barley that he had piled on the gound. He said the banker wouldn't finance a feed mixer wagon! He was caught in a certain philosophy! I invited him

down to the ranch to see how I feed my heifers with 5 gallon pails. My dad and grandfather did before me! He hadn't even considered this option! This example won't fit every situation. Other factors affecting realized management are animal health, geography, climate, genetic potential, and so on.

The total profit picture may not be what it appears to be on the surface. Input costs can easily overrun returns. For example, just north of us a neighbour had the best stand of barley you ever saw. It looked like it would go 100 plus bushels, without a wild oat. It was his pride and joy and the talk of the neighbourhood. His neighbour had a stand that didn't look as good, and had a few wild oats. Recently, it became known that the crop everyone admired actually lost money, while the poorer crop made money due to lower input costs. The moral of the story is, that your management of input costs and marketing skills provide your realized management level and profit. Don't be driven by product advertising, by what everyone else is doing, and by management that doesn't necessarily fit your situation; instead do your pencilled or computer analysis before starting. Everyone will go to a John Deere day to learn more about production and ignore marketing seminars.

An example for the cow man. Practically every extension agent has been telling you if you want a profitable cow herd, identify your productive cows. I've been in the cow business all my life. I don't yet know how to identify a productive cow, - before she is ten years old!

Everyone says, cull the unproductive cows. I know what that means - a cow that doesn't bring in a calf in Wyoming or Alberta goes down the road. But, there wouldn't have any cattle left in Australia's outback if they did that!

Next, you establish a health management program. Great. A lot of our cattle management and handling facilities play right into the hands of the animal health industry. Use some common sense and cow physchology to prevent health problems and keep input costs in line.

Lastly, establish a beef marketing program. I used to think I had all the answers but now I have none that will work for all of you! Everyone of you will have answers that work on your outfit which can address different market niches from weaned calves to natural lite beef.

LOW TECHNOLOGY COW OPTIONS

Our home base is in the high foothills of Alberta, where the native grass is not available until June 15. The problem management-wise is to provide some opportunity to get cows into condition to breed back in June. There are different approaches. Over the years, I have been involved with 11 different breeds. At my Lochend Luing Ranch herd, the 140 cows calve by themselves on a quarter section of Native grass with brush patches. Any breach births are dead calves. We breed every heifer on the place for 42 days and put open heifers in the feedlot in August. Cows and heifers are run together and calve together in March. If they don't wean a calf, down the road they go. I can tell you, I needed another income to stay in business when we first implemented this program. But now that we are rolling, we're doing all right. I don't cull for conformation, feet, etc. The Lochend Ranch bottom line is "Look after the grass and the grass will look after the Ranch". Having cattle that are forage specialists or the ultimate in "No Till" is the basis for my low-tech back to the future approach.

We have to compete with the Australians, New Zealanders and Argentineans. They raise grass-fat cattle. They can really grow grass, but when I see their health management bills I am not so envious. Areas in the sub-tropics have great potential for red meat production if biotechnology can eliminate hoof and mouth disease and tsetse fly, etc. They have the potential to become red meat exporters.

In the Australian outback the inputs are really low. Cattle run on about 1.7 million acres. We market what we can catch with a 'chopper' muster once a year.

Last year the 11,000 head of cattle marketed grossed $46 per head and made money! The product is manufacturing beef. The cattle have a 3-day trip in a truck-train to the meat works. The first time I went to the meat works, I was shocked. Twenty-five percent of the meat was carved out because it was bruised due to horn damage. High management in the Outback means using a polled Droughtmaster or Brahma-cross bull to knock the horns off. There is no castration, vaccination, or dehorning. Aborigines shoot Mickey bulls, water buffalo and kangaroos. Tough management for a tough environment. If a cow is 10 years old, it tells you two things. She is smarter than to get mustered and she has a calf once every other year, to preserve herself.

In my Alberta operation, I realized in about 1974, before it was fashionable, that the ultimate in "Zero Till" was a beef cow. No worry about soil erosion, a rumen to use the roughage nothing else can, self-propelled, a reproduction machine, and produces a whole range of products. My Luing cattle get a minimum amount of feed, and winter with little supplement on native range. Weaning early lets heifers put on some condition on in the fall before winter. My best cattle are 1/4 Simmental, 1/4 Hereford and 1/2 Luing bred to a Charolais terminal cross bull. All Charolais cross calves are sold. All yearling and 2 year old heifers are bred to a Luing bull.

MARKETING OPTIONS

By 1974, more and more people seemed to be sensitive to 'chemicals'. People were asking what they should eat. At the same time, those great medical journals like `Cosmopolitan` and the `National Inquirer` started saying "beef is bad, cholesterol is worse, and fat is the worst," and they were being read. I decided we were in the middle of a wreck, producing a product some consumer's didn't want. I knew the consumer wasn't always happy with the quality of our beef product.

We started marketing some steers with no antibiotics or growth stimulants off grass, with 40 to 50 days on grain. We had no luck in getting small bunches of our

cattle into a feedlot for 40 to 50 days, to supply the market year round. So we fed our own. We got together and put up a little feedlot. Then we went down to Montford to see if he would kill our 'branded` cattle. He said no. We custom kill and have a minimum 2 week ageing.

Then we went to the retailer and asked if he would be interested in this branded 'natural` product. He asked how much money could he get per foot of coffin space. AT that time I didn't even know what coffin space was. This approach didn't work so we bought an old 'Drive In`. We realized our competition was the steak house. You go to a steak house to get a strip steak. Can you buy a strip steak in the average supermarket? NO! Rocky Mountain markets, T-bone, ground and strip steaks from all major muscles. The carcass is not broken in the conventional way, but muscled out.

The retail outlet is a Drive-In. Orders, for example, a 10-ounce strip and a 4-ounce fillet, are taken by phone with your credit card number. When you drive up, you punch in your credit card number in what looks like a calculator. This tells us who you are. The girl at the window hands you the fresh, not frozen, steak order wrapped in old fashioned butchers' paper, with a little brochure on it telling you how to handle it. Market surveys indicate that within an hour most of the beef is eaten, off a barbeque.

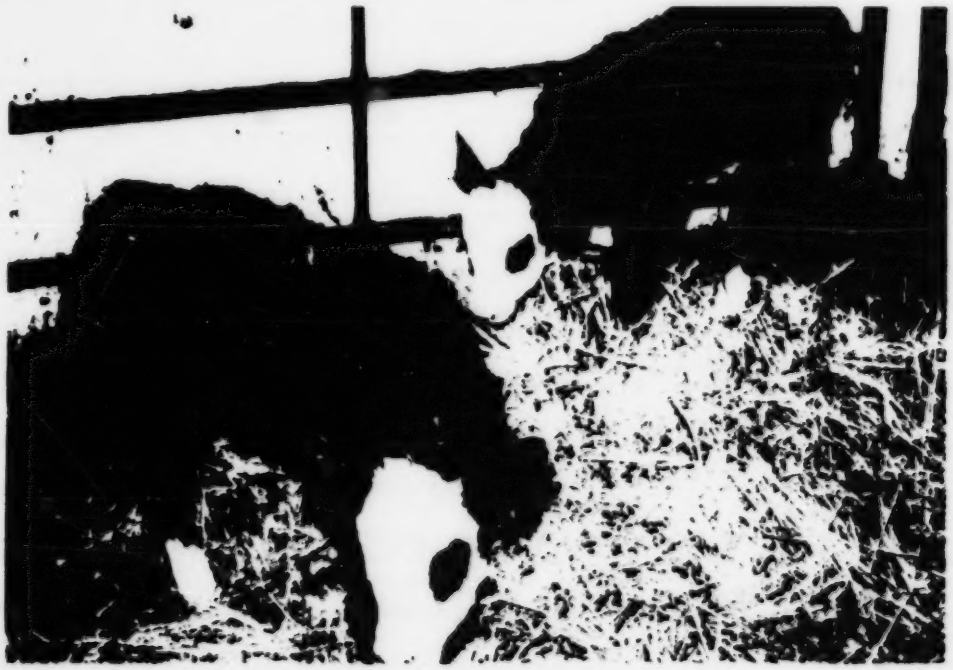
Setting the price was a problem. There is no use starting at the bottom because you have a hell of a time increasing it so we started at the top. In the supermarket, steak was $3.00 a pound so we charged $6.00 or a little less than the $1.00 per ounce charged in the steak house. Price has not been a issue. In Canadian terms, carcasses are at the break between A and B which is low-choice, high-good and yield grade 2 on the American system.

Most consumers won't quite accept yellow fat yet. But no one has spent enough time to determine where yellow fat can be marketed. In New England you can't sell a white egg. There blue and brown-shelled eggs sell for a premium. In western Canada, you can't sell a brown egg.

Top Photo:
Figure 1 — A Flush from a day 7 stimulated donor cow.

Photo at Left:
Figure 3 — tetraparental heifer (chimera)

Bottom Photo:
Figure 2 — Identical Twins from split embryo.



With these 'natural' lean cattle we meet consumer perception and demand. Our meat sells on its reputation for quality and reliability by word of mouth. First time consumers are attracted by satisfying their fear, and it is real, of antibiotics and chemicals. Our market niche is a small part of the total cattle business so you people in the hormone and drug industry, don't need to pack up and leave. 'Natural lite' products satisfy a perceived consumer need. There is just enough scientific basis for the perception of misuse, not the proper use, but the misuse of antibiotics and the misuse of steroids to cause a problem. Continuing sales are based on Reliable Quality, Convenience and Prestige!

Develope a system that will work on your farm or ranch. I believe that because some cattle can gain 5 pounds per day, doesn't mean that they are always the most profitable. I don't think bigger is always better except you can get into a wreck faster.

HIGH-TECH OPTIONS

Let's change gears a little and look at other options - high-tech. The oldest embryo transplant centre in the country was developed because of a demand for exotic breeds of cattle. The technology was there; this was the application. Embryos can be frozen and shipped world-wide. Last year there were over 10,000 seedstock embryos shipped out of Canada. It is a fair kind of export market that hasn't even been fully utilized yet. It is a market that exists for a select group of cattle at the high-tech end of the industry. *(See figure 1)*

Other techniques involving what is generally conceived as genetic engineering, are now starting to come into force for the livestock industry. We can take an embryo, like one of those in the photo and split it into two to produce identical twins. *(See figure 2)* We can take two embryos and put them together.

The heifer in the next photo is my pride and joy. *(See figure 3)* Let me tell you a little bit about her. Two of her parents are Charolais, double-muscled and polled. Two of her parents are Jersey.

We took those two embryos and put them together to see if we couldn't take the extra growth associated with double muscling and slow it down a little while the calf was in the uterus of the cow so we didn't have to take a 150 lb calf out the side door. At the same time, we were trying to take advantage of the "white veal" potential of a double-muscled animal. A 800 lb animal that could sell at white veal prices!

Unfortunately, it was a little like the story when Marilyn Munroe and Albert Einstein met. Marilyn said to Albert, "Wow, with my looks and your brains we could have kids that could be real knock-outs". Albert knew a little more about nature and knew it was strictly chance as to what genetic recombination would result and he said, "Yes, I agree, but we would run the risk of having children with my looks and your brains". That is what we got in this heifer. As one of my neighbours described her, who would want to produce a 'polled Longhorn'! What happened in scientific terms was that the Jersey cells completely suppressed all the double-muscling of the Charolais cells.

A more dramatic illustration of this was when a sheep embryo was combined with a goat embryo. The animal, where it has wool, the cells were derived from the sheep parents. Where the hair is, the cells are derived from the goat parents. Her face shows that half was developed from the goat parents and the other side from the sheep parents. This kind of research was to see if a way of expanding some of our endangered species could be developed.

In our normal embryo transfer procedure, we have a superior donor cow produce a number of offspring all the same age as opposed to over a 10 year lifetime of the cow. We can put the embryos together or split them and produce identical twins. A number of people are producing identical twins like this so that they can have two

identical bulls with the same genetic potential. If there are 60 cows to breed to one bull, an embryo split divides the bull power into two and gets more calves from a 'bull' faster.

Another aspect of genetic engineering involves introducing genes which contribute to economic characteristics in animals. The idea here is to perhaps introduce disease resistance and increase growth, etc. Now we are talking high-tech options. We did some genetic engineering with mice. In one particular transgenic mouse line, that is the name we use for genetically engineered animals, we have added a small gene that causes the multiplication of the cells that produce fat. This particular mouse is grossly overweight. But from an efficiency point-of-view, this mouse is unbelievably efficient, particularly when you consider the fact that there is 2.25 times as much energy in fat as there is in carbohydrates. But 'Fatty' has some reproductive problems. Another transgenic line has a human growth hormone gene incorporated into its genome and the animal is engineered in such a way that whenever this animal's drinking water has zinc in it, the growth hormone in the liver is switched on augmenting the growth hormone produced by the pituitary gland of the mouse. It grows from 1.75 to 2 times the size of its littermates that have not been genetically engineered. Because it is in the mouse's genome, it is inherited from generation to generation. There are many things we don't know about these particular kinds of animals. I'm not saying we have answered all the molecular biology and physiology questions in these animals.

That type of phenomenon is a reality./ *(See figure 4)* The same procedure has been used on pigs, sheep and now cattle. In the high-tech side, I see some niches that will be available that are 180 degrees away from the natural beef product we talked of previously. We will produce some novel animals and genetic engineering and recombinant DNA will have a lot to do with that. It will involve new kinds of biologics, new kinds of vaccines, new kinds of antibiotics, and new kinds of

(Figure #4)

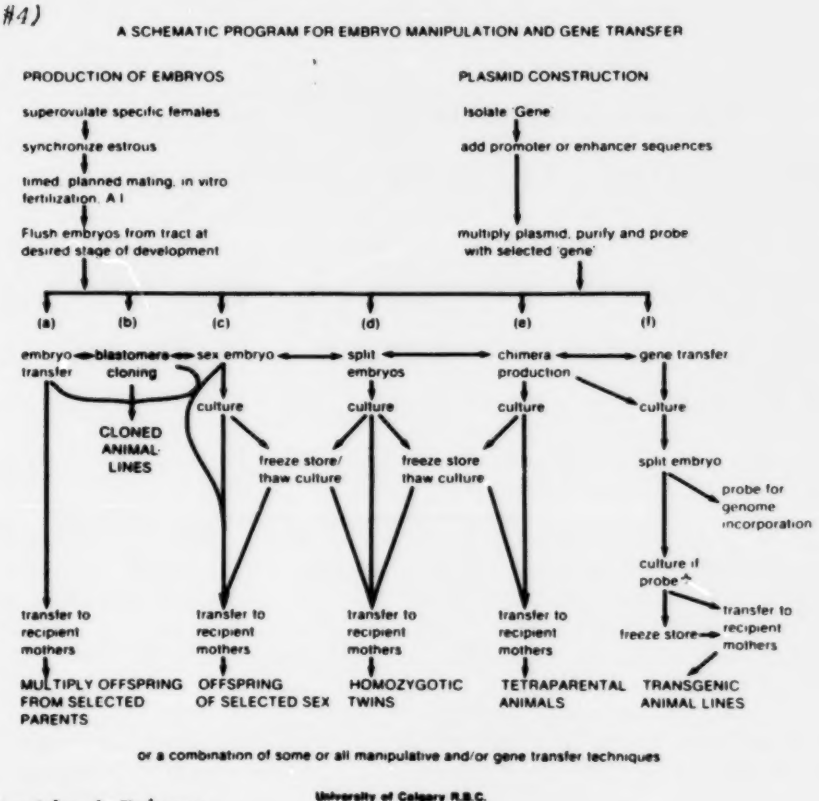
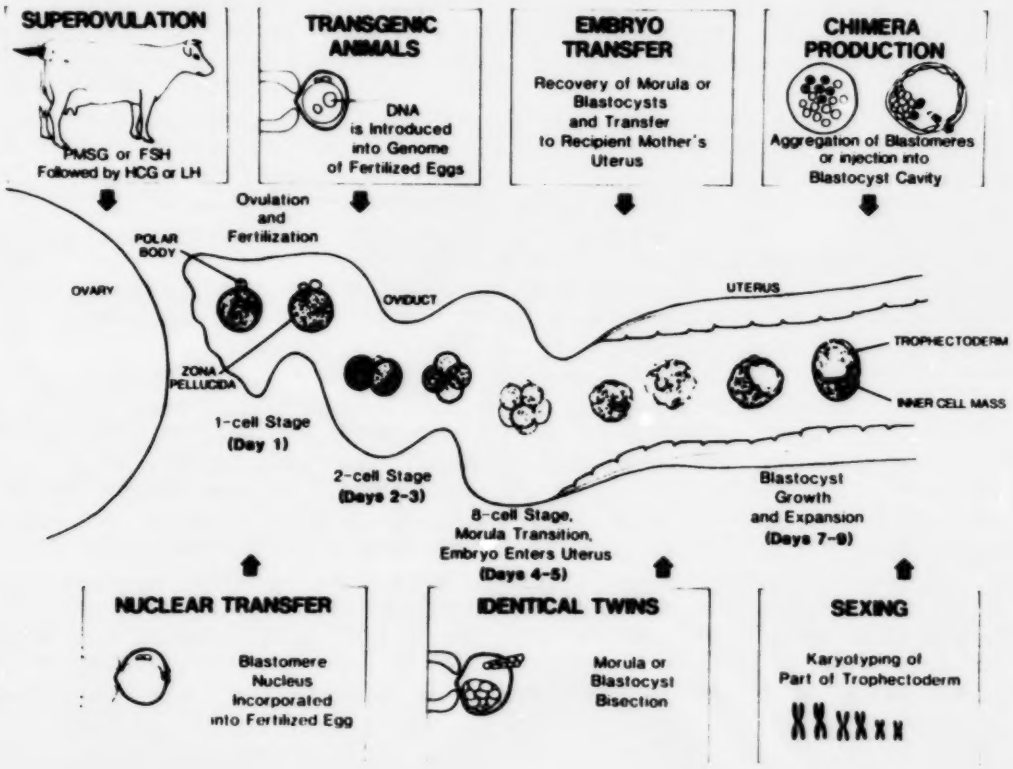


Figure #5 - Genetic & Embryo manipulation for high technology)



implants. Like the genetically engineered bovine growth hormone which is causing a lot of controversy at the present time. It causes dairy cows to keep producing milk over lactation. Of course, with the American dairy buy-out program in the US, it is interesting that there is a big demand. *(See figure 5)*

Some people have said this type of high-tech management will be profitable for the big corporations and big corporate farms. I don't think so. I think the individual farmer will utilize this niche. Take the example of the small dairy operator. Instead of meeting his cash flow by going from 50 to 70 cows as he would at the present time, he will stay with his 50 cows, use growth hormone, and get the same milk production as he would have out of 60 or 70 cows. As far as I know, only the individual farmer has the knowledge, the management and the initiative and drive to make these kinds of things work.

Let me give you another example. We will also use recombinant DNA to help in disease control. We will probably sometime in the future have animals that have disease resistance built, genetically engineered, right into them. We may change their composition or change their growth rates. Possibly we will genetically engineer a cow to produce a milk that has a casein or milk protein content that produces better or different kinds of cheese. There are other programs designed to make the cow produce antibodies continually so that all of her milk is like colostrum, through which her calf will have this disease resistance all the while it nurses.

In addition to that, I see the opportunity for what I call animal production packages. These will be animals which give milk containing something like a human insulin. The human insulin would be secreted into the milk, and separated out to provide an alternative to genetically engineered insulin that is currently available and which 99% of all insulin-dependent diabetics are taking. So there are some real opportunities for biologics in this area. It may sound ridiculous, but one cow can

produce the same amount of a peptide in her milk, using her fermentation vat or rumen, as a 1000 liter fermenter can with all the engineering and the paraphernalia that goes with it. So it is not really farfetched and will be an opportunity in the future for some of us to have an alternative and option for cash flow.

It will mean that a calf born in the snow someplace will be from a cow producing biologics that aid in its health and survival. Products will be available for feedlots that further ensure the survival of that calf. One of the first transgenic or genetically engineered calves in the world has a gene which confers some disease resistance. That calf and its dam were challenged not too long ago. The cow was in trouble but the calf was okay due to the interferon in its system.

While we may increase and change the composition of cow's milk, I suspect that in the furture the dairy cow will be derived from a Jersey and will have a milk composition more like human milk than cow's milk because fifty percent of the human population cannot fully handle cow's milk.

In the not too distant future, instead of blood-typing, Purebred Breeders will use DNA fingerprinting, DNA probe analysis and repetitive fragment analysis to certify pedigree analysis. Biotechnology will enable us to tell who the parents of a particular animal are, not merely exclude them.

We will have electronic identification. Such is being introduced for horses at present. You'll identify an animal with a particular sensor. The sensor tells the animal history. The critical trials with this type of instrumentation are currently ongoing and are primarily designed for dairy cows as an aid in detecting heat for AI. In the future, these sensors will be implanted into cattle so that as soon as the temperature starts to rise, which is usually a day or two before the ears start to droop, you have a prewarning of forthcoming sickness. These are some of high-tech options which may provide a profitable option to a limited land base or to utilize your knowledge and management skills.

IN CLOSING

I want to go back and reinforce what I said earlier. This is what Will Rogers said about the cattle business:

All you have to do is buy
stock, wait for the price to
go up, then sell them. And
if the price doesn't go up,
don't buy them.

Whether you exploit the operation you have at the present time, at the high-tech end or the low-tech end, you will have to combine your management, your financial resources, your geography and your climate for maximum profit.

We are in an era where government is by pressure group and there are two things that are paramount here. Those of us involved in food production make up about 4% of the population. That is a small number of votes. We don't have an effective opposition to consumer perception; we don't have an effective opposition to the 'animal rights' groups. The declared objective of the animal right's group in the US and Canada is to eliminate what they call factory farming. They have the money and the dedication and can manipulate the media for that other 96% of the population. Secondly, we have consumer groups. Most of you were in the cattle business in 1973. One housewife in Denver effectively took on the whole continent's beef industry and brought it to its knees. She said it was totally wrong that consumers should be ripped off by high beef prices. That is consumer pressure. Make sure you know and respond to consumer demands.

The Oregon Country Natural Beef Program illustrates a direct link between producers and consumers. That link is needed and it doesn't matter whether you grow pumpkins outside the North Battleford, wheat in Estevan or run a cow-calf operation in Pierceland or a feedlot in Kindersley, if you forget about that consumer, then

everything else you do is for not! We must remember that our market is exactly as the consumer sees it.

One common approach is to cry for government help. That ain't the way you gotta do it, ladies and gentlemen. From my point-of-view, our salvation is in educating, in talking to, and in providing the consumer with all the quality cheap food that we are capable of in North America. No other place in the world has the cheap wide selection of quality food that we have in Canada and the United States. Unfortunately, through a whole bunch of accepted mismanagement, many of us were responsible for, we are on the end of a tiger's tail, in danger of falling off. I suspect we will fall off. The catch is to land on your feet, running, hopefully with a helping hand from the consumer.

REVIEWS

Embryo manipulation and gene transfer in domestic animals

R. B. Church

The manipulation of reproduction through artificial insemination and embryo transfer has had a major impact on genetic strategies in animal production during the last 15 years. The advent of estrus synchronization, nonsurgical embryo collection and transfer, and embryo freezing have allowed a move from the laboratory to the farm. Other aspects of embryo manipulation which have a major impact on breeding strategies include embryo splitting to produce monozygotic twins, *in vitro* fertilization, cross species fertilization, embryo sexing, production of tetraparental animals (chimeras) and nuclear transfer. Genetically engineered animals are now being produced, although very little of the molecular biology and physiology of increased production efficiency is understood.

In recent years, tremendous progress has been made both in the manipulation of reproduction and in genetic engineering techniques which can be utilized in the improvement of current livestock species and in the development of novel animals. Transgenic animals (see Glossary) containing foreign genes can now be produced and offer new opportunities for genetic improvement of traditionally important characteristics of livestock species. The potential gains in livestock production (Fig. 1) include improved efficiencies of reproductive performance, enhanced growth, disease resistance and changes in milk and wool production and composition. The introduction of growth (or growth hormone related) genes may increase growth, although an understanding of the molecular physiology of growth will be necessary to ensure that such animals are capable of a normal reproductive lifespan.

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Transgenic animals can also be viewed as production systems for useful peptides which require post-translational modification prior to secretion (see accompanying paper by Clarke *et al.*, p. 20). For example, a transgenic animal having a fusion gene for a medically important protein coupled to regulation sequences for a milk protein could secrete the useful protein into the milk, from which it could then be isolated.

Once a successful transgenic animal has been produced, the production of sufficient numbers of the genotype to have an impact on livestock productivity and profitability requires the successful application of embryo transfer, manipulation and nuclear transfer (cloning) techniques.

Embryo transfer

Planned matings provide an increased opportunity to market the improved genetics both of proven elite females and of progeny-tested superior sires. The manipulation of reproduction by the use of artificial insemination and embryo transfer has had a major impact on animal breeding programs for many years. The dairy industry adopted artificial insemination in the 1950s. In the 1970's, demand for continental beef breeds sparked the development of embryo transfer techniques offering increased numbers of offspring from limited gene pools. Embryo transfer is now also commonly used to produce sires for progeny testing in artificial insemination programs.

Nonsurgical embryo recovery and transfer (Fig. 2) has allowed a move from the laboratory to the farm, so that breeders can now produce increased numbers of offspring from specific planned matings without the fear of decreasing the reproductive performance of the valuable female through surgical damage[1]. The embryo transfer industry now produces thousands of pregnancies each year world-wide, and has been the subject of a number of reviews[2–6].

Embryo transfer and handling also provide opportunities beyond simply accelerating elite livestock production.

- *In vitro* fertilization has been achieved in the bovine[7], although the technique needs refinement.
- Sexed embryos or sperm would be a major advantage to the animal breeder; although no reliable method of sexing sperm has been developed, rabbit blastocysts have been sexed[8] and day-12 bovine trophoblast cells have been karyotyped[3] (Fig. 3g).
- There is the potential, in the bovine species, for disease control and specific pathogen-free production of progeny because most infectious diseases do not appear to affect embryos whilst they have an intact zona pellucida[9] (at preimplantation stages).
- Embryo transfer and the production of chimeras (see below) offer the prospect of increasing the population base of endangered species[10].
- The development of methods for embryo culture and embryo freezing[11] has increased the flexibility of embryo transfer programs by reducing costs and transport difficulties (Fig. 4).
- Embryo transfer has enhanced the testing of progeny for genetic defects: females suspected of carrying defects can be superovulated (see

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Glossary) and the embryos transferred to unrelated recipients. These pregnancies are usually terminated in the first trimester and the fetus examined to determine whether the originally observed birth defect had an environmental or genetic basis[12].

Embryo manipulation

Recently, the focus of embryo research has shifted from embryo recovery, storage and transfer to micromanipulation of the embryo itself. Part of the impetus for this has been provided by a lack of knowledge of the culture conditions which would allow all embryos to develop *in vitro* through to late preimplantation stages[13]: using non-ideal culture conditions, a large proportion of the embryos do not survive the culture period and are wasted. By manipulating early embryos (e.g. by separating cells of 4-cell embryos or by nuclear transfer), the number of genetically identical embryos can be greatly increased, thereby improving the chances that any given genetic identity can progress to implantation and beyond.

Embryo splitting

Micromanipulation techniques allow production of identical animals through separation of the early cells (blastomeres) of the embryo (Fig. 3f). Such blastomere separation has been used to produce up to four genetically identical animals from a single 8-cell embryo[13]. Simple bisection of slightly older preimplantation embryos (morulae or blastocysts) has been used to produce identical twins in a number of species[6,14–16]. In cattle, morula splitting to produce monozygotic twins is used routinely to obtain higher pregnancy rates (about 110%) than those obtainable by normal embryo transfer[17]. Some breeders have been quick to recognize the extra bull power which is available for natural service when identical twin bulls are used in the same herd. However, some breeders have been dismayed that color patterns are not identical in all monozygotic pairs (Fig. 5).

Chimera production

Another powerful embryological technique is the aggregation of blastomeres from a number of embryos[18], or the injection of a single blastomere into the blastocyst cavity of an embryo[19], to produce a chimera (Fig. 3d). Chimeras can be formed from embryos of a single species or species barriers can be transgressed, as has been done for sheep–goat and sheep–cow chimeras[13]. Such interspecies chimeras are constructed so as to neutralize the incompatibility between the fetus and the recipient mother's uterus: the heterologous inner cell mass (which will give rise to the fetus) is placed inside a homologous trophectoderm (which will interact with the maternal tissue). Interspecific chimeras offer unique opportunities for the study of cell differentiation and interaction during development.

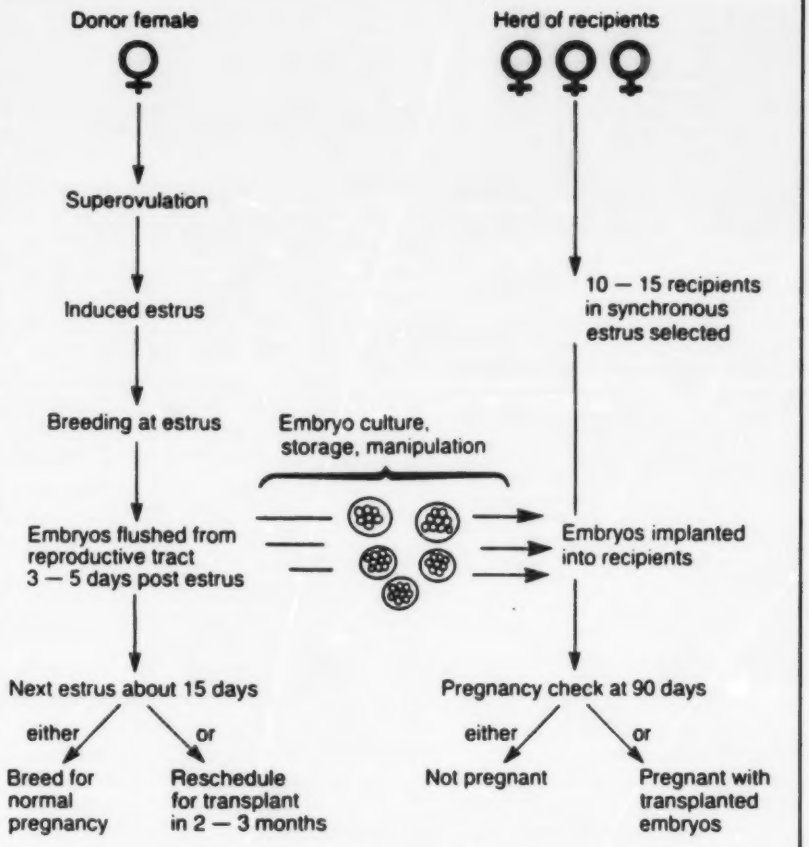
Germline involvement from the two genomes contributing to a chimera is determined during development rather than when the chimaera is formed: the germ cells of any particular chimeric animal may or may not be affected.

Chimeras may also be useful in the modification of gene expression. An example in the bovine is the production of tetraparental chimeras by fusing 'double muscled' and normal embryos. The double muscled phenotype is a characteristic of Charolais cows: the trait is desirable because it offers the economic advantage of producing veal-type meat (due to muscle hyperplasia) on 350 kg mature animals rather than on 90 kg calves. However the double muscled genotype also has severe drawbacks from the point of view of animal management: it gives rise to extra-

Fig. 1

Factors in the economics of animal production.

Fig. 2



Non-surgical embryo collection and transfer procedure. In the bovine, non-surgical embryo collection is carried out by passing a catheter into the horn of the uterus; 150–500 ml of media is introduced into the uterine horn and removed to flush the embryos from the tract. The embryos are recovered from the flushing medium and subsequently transferred through the cervix into the uterus of recipient cows in a manner analagous to artificial insemination.

ordinary fetal growth (the animal is approximately 65 kg at parturition, compared with 40 kg normally, and must be born by Caesarian section); the calves require intensive nursing to reach maturity; and the animal is reproductively unfit.

It is hoped that chimeras of double muscled and normal embryos will express the desirable phenotypes without the disadvantages. Preliminary results (R. B. Church and R. Bricker, unpublished) show that although the chimeras are genotypically a mixture of double muscled and normal cells, neither of the cell types expresses the hyperplasia phenotype. They are born at normal weight, require additional nursing and exhibit no extra muscle growth (Fig. 6).

In contrast, the most spectacular chimeras are the 'geeps'[20]; these chimeras of sheep and goat genotypes show phenotypic characteristics of both parental genomes.

Such procedures provide an opportunity for the introduction of genetically engineered EK cells into embryos as a vehicle for gene transfer. EK cells are pluripotent cells derived from that part of the embryo (the presumptive primary ectoderm) which gives rise to the germ line. Since EK cells can be maintained in culture, novel DNA constructs can be introduced into them and the incorporation and expression of that DNA can be assessed *in vitro*. This allows the selection of suitable cells for transfer into embryos, and hence significantly enhances the production of transgenic animals. EK cell lines have been successfully obtained from mouse embryos[21] and research is now in progress to derive similar lines from domestic animals.

Nuclear transfer and cloning

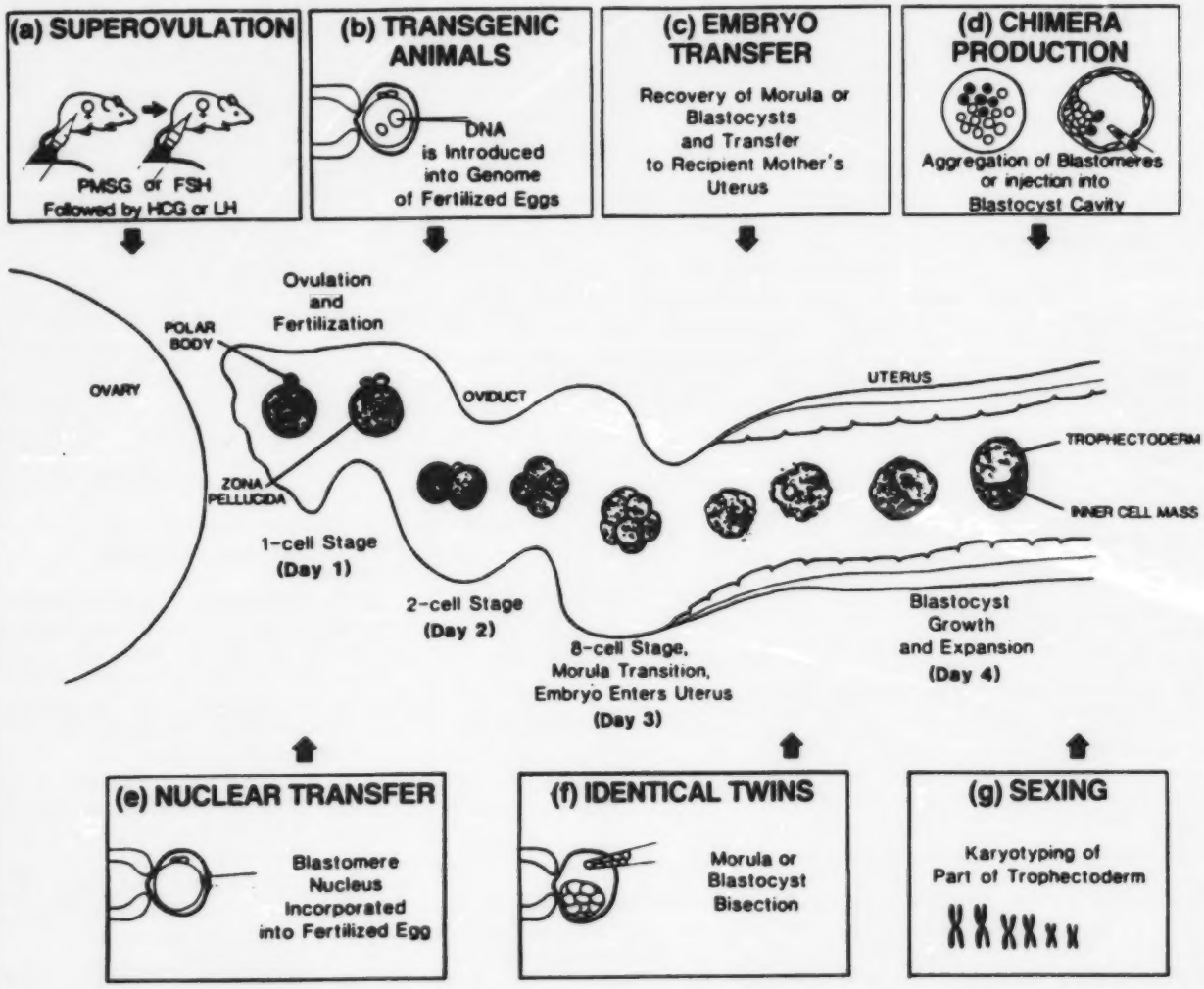
The ultimate goal in embryo manipulation for livestock production would be the development of techniques for successful cloning of the genetic elite of any livestock species. Recently, Willadsen[22] has produced identical lambs by the fusion of blastomere nuclei with anucleated oocytes (Fig. 3e). Such embryo reconstitution allows a considerable number of offspring to be produced from a single 8-cell embryo. The application of such nuclear transfer techniques in domestic animals will have a major impact on genetic programs. What, for instance, will be the effect on traditional practices of the existence of whole herds of animals which are very close relatives of each other (half-siblings at least)?: and under these circumstances how will diverse gene pools be maintained?

Gene transfer and transgenic animals

Animal scientists with an interest in molecular techniques have been intrigued for many years by the possibility of genetic engineering. However, until conditions for handling mammalian preimplantation embryos were available, little progress could be made. Possibly the first attempt at alteration of an animal genome with exogenous DNA was carried out by Munro[23] with chickens. He injected DNA isolated from bantam fowl, which are colored and have a distinct claw structure, into the ovaries and testes of white leghorn chickens; he obtained some offspring which had patches of dark feathers and the bantam type claw. An early attempt was also made to develop a 'heterosis index' based on observed differences in the number of copies of repetitive DNA sequence families between inbred lines of chickens[24]. Studies combining preimplantation embryo manipulation and molecular biology have been a focus for genetic engineering of livestock species for some years in our laboratory[25].

It is now possible to introduce foreign DNA into the germ line of livestock species to produce transgenic individuals. The most common method of producing transgenic animals is to inject DNA sequences into the fertilized oocyte[26,27] (Fig. 3b). There are some limitations to

Fig. 3



The central part of the diagram shows the pattern of mammalian preimplantation development; the boxes show the opportunities for manipulation of the embryo, at the stages indicated by the arrows. The timing of development is appropriate to the mouse, but the basic concepts are applicable across all mammalian species: (a) superovulation, (b) introduction of DNA by injection, (c) embryo transfer, (d) chimera production, (e) transfer of nucleus, (f) embryo splitting, (g) embryo sexing.

microinjection since very little is known about the process of integration of DNA into the genome, or about the control of foreign gene expression. Indeed, many animals do not express genes incorporated into their genome[28,29].

The isolation of desired gene sequences and the regulatory DNA sequences required for controlled expression in a genetically engineered animal is not an easy task but it is possible: a fusion gene with metallothionein regulatory sequences coupled to the rat growth hormone gene was injected as a pBR322 construct into mice by Palmiter *et al.*[27] and initiated considerable speculation about the possibility of introducing desirable genes into animals. Transgenic rabbits, pigs and sheep[30] and cattle[31] have subsequently been produced.

A number of structural gene plus promoter plus enhancer combinations have been incorporated into mouse and bovine oocytes. Cloned DNA sequences are injected into either the pronucleus or the ooplasm of fertilized oocytes in one picoliter of buffer. DNA can be introduced into over 100 embryos per hour and incorporation of injected sequences confirmed by Southern DNA probe hybridization. About 25% of all injected mouse embryos develop as transgenic offspring. However, a high frequency of sterility and other physiological problems associated

with transgenic animals has been noted[6,28].

Transgenic livestock

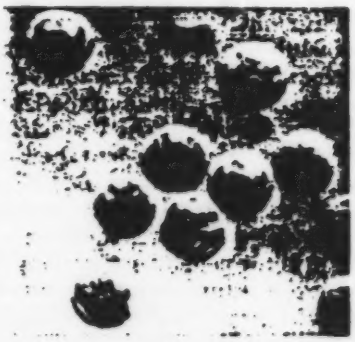
Hammer *et al.*[30] reported that of 1032 sheep and 2035 pig ova injected with DNA and transferred, the integration frequency for the MT-hGH fusion gene was 1.3% and 10.4% respectively. Only 10% of the injected sheep eggs developed to blastocysts while 23% of the injected pig eggs developed to blastocysts. Only 1 of 73 newborn sheep incorporated the fusion gene. The resulting offspring have not shown normal physiology.

In the bovine, superovulation, natural mating and subsequent flushing yielded 1161 fertilized oocytes for microinjection with fusion constructs. Only 7 out of 126 calves born were positive for incorporation of the fusion gene into their genome (Table 1), and only one shows evidence of expression (R. B. Church, unpublished).

This relative lack of success in producing transgenic livestock in comparison with mice is probably not a function of species differences. For instance, although the pregnancy rate in cattle implanted with embryos injected with DNA is low compared with cattle implanted with non-injected embryos (Table 1), DNA incorporation in mice is also associated with a relatively high occurrence of mutagenic effects. Rather, the lack of success is more likely to be due to our lack of knowledge of development at the molecular level, the provision of inadequate culture conditions and the use of inappropriate DNA constructs for livestock species.

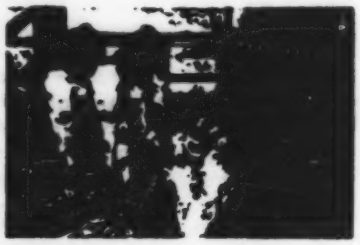
The *in vitro* handling and culture of preimplantation embryos has been the subject of significant research for the last 30 years. During that period, conditions for the successful culture of preimplantation mouse embryos from the one-cell stage to blastocyst have improved such that up to 85% of cultured embryos develop normally. As a result of the work of Brinster and others, the energy requirements and other metabolic changes associated with early preimplantation gene

Fig. 4



Bovine embryos collected non-surgically from superovulated donor cows at the early morula stage, frozen to −196°C, stored, thawed and cultured to the late morula–early blastocyst stage for transfer to recipient cows; 50% of these frozen/thawed embryos will develop and produce live calves. Transport of frozen embryos is much more economical than transport of animals, and animal health testing is made simpler by the use of frozen embryos.

Fig. 5



Monozygotic twins with recipient mother cow. Such twins are produced by splitting embryos at the morula stage. First a slit is made in the zona pellucida. Then one half of the embryo is withdrawn, using an appropriately sized pipette, and injected into an empty zona pellucida. Finally, both half embryos, in their separate zonae, are transferred to hormonally synchronized recipient mother cows. Although the twins have identical genotypes, differences are seen in the extent of phenotypic color pattern development.

Fig. 6

A chimeric heifer produced by fusion in vitro of two zona pellucida-free early morulae. After the two embryos have made close contact in culture, they are inserted into a single zona pellucida and transferred to a synchronized recipient cow. This heifer was derived from an embryo from white, double muscled, polled Charolais parents and an embryo from brown, slightly muscled, horned, Jersey parents. Brown spots are from the Jersey cells and white, polled characteristics from the Charolais cells. Phenotypic expression of muscle development is entirely of the Jersey type for all cells.

Table 1

Viability of fertilized bovine embryos injected with DNA constructs[a]

	No. of fertilized oocytes recovered	No. embryos transferred (%)	No. of live calves born (%)	No. of calves with incorporation of injected DNA into the genome (%)
Embryos injected with DNA	1161	641 (55.2)	126 (10.9)	7 (0.6)
Embryos not injected with DNA	1562	1270 (81.3)	689 (42.8)	—

[a]Three different constructs were used but no significant differences in incorporation of DNA were seen between them.

Glossary

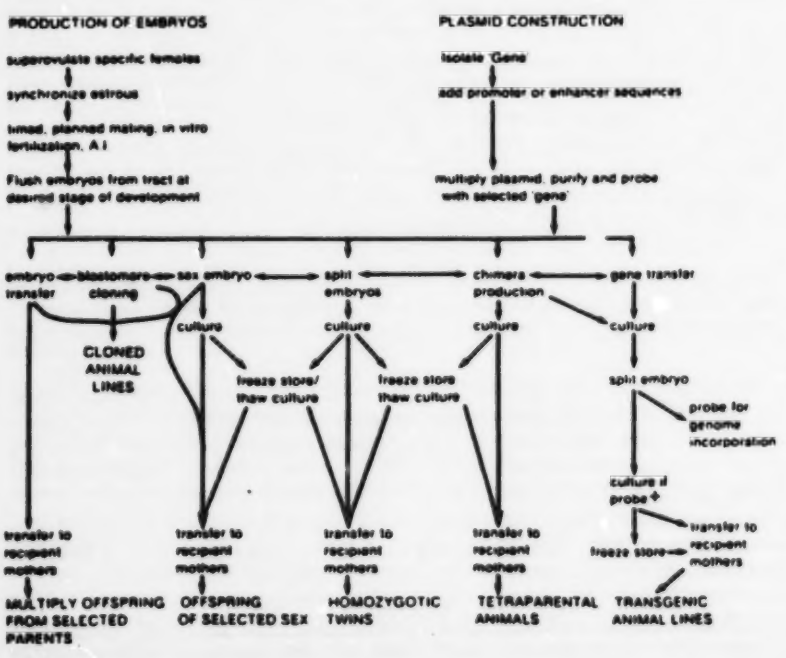
A transgenic animal – one whose genetic composition has been altered to include selected genes from other animals or species by methods other than those used in traditional animal breeding.
Superovulation – controlled stimulation of the ovary. Normally, a cow ovulates one egg per estrus cycle. Hormonal stimulation of the ovary in mid estrus cycle is achieved through the use of pregnant mare serum gonadotrophin or follicle stimulating hormone followed by luteinizing hormone and induced estrus as a result of prostaglandin F2 alpha administration. Ideally, 4–10 eggs are ovulated per ovary as a result of superovulation, and an average of four pregnancies per donor animal stimulation can be achieved.

expression are relatively well known. The timing of expression of the maternal genome is well documented for housekeeping genes as well as for specialized genes associated with development in the mouse. This knowledge is a result of the more readily available supply of large numbers of synchronized mouse embryos: the mouse yields about 30 embryos per superovulation.

Domestic livestock species, by contrast, are single or low number ovulators and the success of superovulation is much more variable: stimulation can result in limited ovulation, limited fertilization or abnormal development. Knowledge of basic patterns of gene expression, metabolic and physiological aspects of domestic species development are in their infancy when compared to the mouse. Each species has unique features in preimplantation development. For example, in most strains of the mouse, eggs fertilized *in vitro* do not culture past the two-cell stage; however, embryos fertilized *in vivo* and collected at the two-cell stage are easily cultured to late preimplantation stages (blastocyst) of development. In contrast, in the bovine, fertilized eggs collected at the one-cell stage can be cultured to the eight- or ten-cell stage prior to a similar kind of blockage. However, in the mouse, the development of specific animal strains has permitted the two-cell block to be overcome whereas in the bovine, such strains have not been identified. The importance of this is that the chances of producing viable progeny after implantation are greatly increased with more highly developed embryos (the success rate in producing progeny from transferred eight-cell embryos is half that from transferred morulae).

Lastly, the lack of knowledge of the molecular biology of physiology and reproductive fitness in domestic animals makes the selection of promoter and structural sequences for a construct very difficult.

Fig. 7



A combined program for embryo manipulation and gene transfer.

Conclusion

The objectives of embryo manipulation and gene transfer experiments in livestock production are to develop methods for the propagation of genetically elite and novel animals (Fig. 7). The aim is to create transgenic cattle which will be an asset to breeding programs and/or are capable of producing unique biologically important peptides.

Work with large domestic animals in any transgenic program requires a considerable investment in the number of animals required for such experimentation. The logistics of recovering sufficient newly fertilized bovine embryos, their microinjection or transfusion, culture in the laboratory to select those which are developing normally, and their subsequent transfer to recipients, is a major management task. But the successful development of technology to allow genetic engineering and embryo manipulation of domestic animals has great importance to animal breeding strategies.

Acknowledgements

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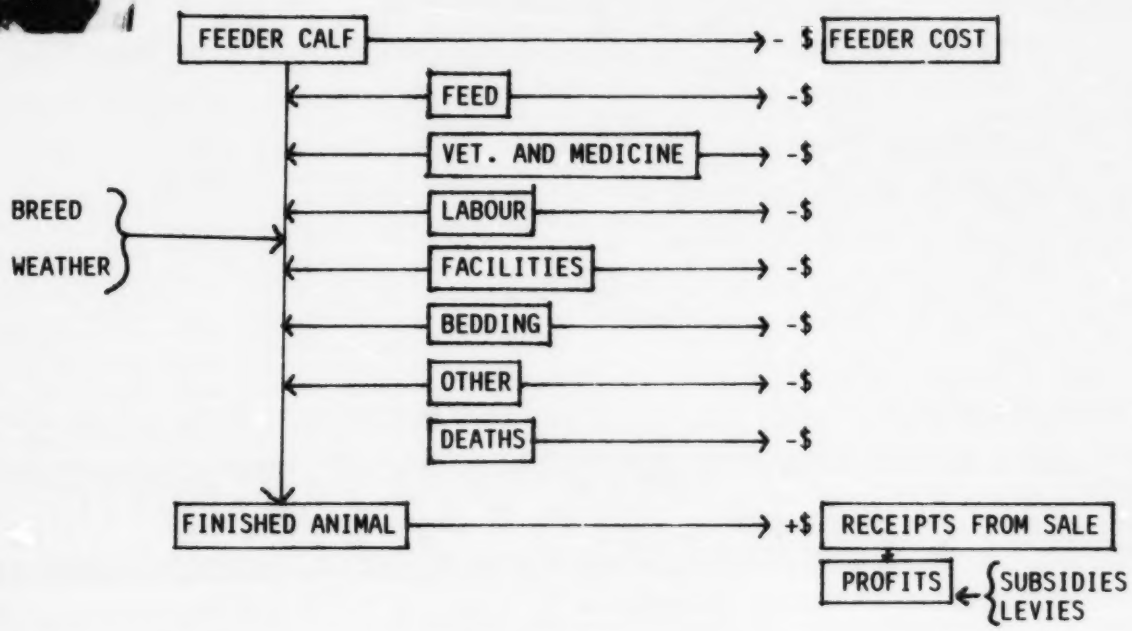

Figure 1. Factors effecting feedlot profits

The above figure (Figure 1) outlines the many factors which effect the profits from finishing calves. Profits are the excess of receipts over feeder and input costs. Management factors determining growth and profits include the program of feeding, medication, implanting, labour, the facilities, and bedding. Nonmanagement factors that will influence growth of the calf are weather and the breed, or breed cross, of the calf. Nonmanagement factors directly affecting profits are subsidies and producer levies.

From the premiums paid for feeder calves of specific breed crosses, the breed or breed cross of the feeder calf does appear to have an effect on feedlot profits. In the summer of 1986, thirty-one livestock auction market managers in western Canada were contacted to determine if the price for calves of similar size differed by breed cross in their market. The results indicated that within the parkland region of western Canada, foreign breed crosses sell at a premium to British breed crosses in the 200-275 kg (440-600 lb) weight range. The premiums over British crosses for steers were $10.58/100kg ($4.80/cwt) for Charolais, $9.92/100kg ($4.50/cwt) for Limousin, and $4.41/100kg ($2.00/cwt) for

Simmental. In the prairie region of southwestern Saskatchewan and southeastern Alberta, Simmental were discounted $8.38/100kg ($3.80/cwt) and the premium for Charolais and Limousin were similar. The major reason stated for the different prices was grade related. It was indicated that to reach an A1 or A2 grade, too many Simmental crosses had to be fed to too high of a weight and be on feed too long. The straight British crosses received a lower price because of lower rates of gain and a greater likelihood of overfinishing at the desired finish weight. In November and December of 1987, 17 feedlot managers and order buyers from western and eastern Canada were contacted to determine if they have breed preferences and what premiums they pay. Most indicated they had a breed cross preference, or did not want certain breed crosses, for their feedlot and would pay premiums similar to and often greater than those indicated. Most of the feedlots fed a silage-grain diet and few would feed high percentage Simmentals. It was indicated that high percentage Simmentals had to be fed differently to get top grades at the desired weight. A distinction was also made between "good" and "average" Limousin where the price of average Limousins was equal to British breeding.

Are the premiums and discounts paid for specific breed cross calves justified by their feedlot performance? If so, what are the major factors determining the differences? A study was undertaken at the Brandon Research Station to determine the effect of breed on the returns from finishing calves and whether the method of pricing the final animal effected returns (liveweight, carcass, or lean). To do this, the study determined the price that could be paid for feeder calves of specific breed crosses, when taking into account all costs of production and the quality of the finished animal. A high feeder calf price would be associated with a profitable calf.

THE STUDY

The study was based on steers fed at the Brandon Research Station over a six year period from 1973-74 to 1978-79. The calves were three-breed cross calves from the Foreign Cattle Breed Evaluation program. Charolais (C), Simmental (S), Limousin (L), and Chianina (Chi) terminal sires were mated to Hereford-Angus (HA) dams and nine dam crosses produced by mating C, S, and L to Hereford (H), Angus (A), and Shorthorn (N). The breed crosses are in Table 1.

Table 1. Three-breed cross calves in the study

Terminal sires	First-cross dams
C[+]	HA SH SA SN LH LA LN
S	HA CH CA CN LH LA LN
L	HA CH CA CN SH SA SN
Chi	HA CH CA CN SH SA SN LH LA LN

[+] C=Charolais, S=Simmental, L=Limousin, Chi=Chianina, H=Hereford, A=Angus, and N=Shorthorn

Calves from the project were weaned in October or November, depending on the year. The weaned calves went directly to a 28-day "warm-up" during which time they were gradually introduced to an all-concentrate pelleted grain diet. The diet composition is in Table 2. Calves were penned by breed cross of dam for the first three years and by terminal sire for the last three years. Individual animals were weighed every 28 days until sent to slaughter. Weights during the feeding stage were taken after an overnight stand without water. Steers to be slaughtered were taken off feed and water at 4:00 PM, weighed the next morning at 6:00 AM, and hauled to a local packing plant to be slaughtered that morning. Feed consumption in each pen was measured and recorded for every 28-day period. Animals were slaughtered at either 13 1/2 months of age or at 15 months of age. A total of 1039 steers were slaughtered over the 6 years and carcass data were obtained for each animal.

Table 2. Feedlot Ration+

Ingredient	Percent of ration
Barley	50.0
Oats	30.0
Dried molasses beet pulp	15.0
Molasses	2.8
Calcium phosphate	0.5
Limestone	0.75
Urea (45% N feed grade)	0.5
Salt	0.4
Vitamin A	0.05

+ Note that this was the ration used throughout the study. It may not be the least cost ration given current grain prices.

PERFORMANCE OF THE STEERS

Beginning and final weight, average daily gain to 140 days on feed and to the final weight, and feed conversion to 140 days on feed and to final weight are in Table 3. The growth rate of the Charolais, Simmental, and Chianina sired calves were similar, as indicated by the daily gains, with Limousin lower. Feed required per unit gain for the C, S, and Chi were similar, with L higher. The calves that were 1/2 Limousin grew slower and required more feed per unit of gain than did calves from the other three terminal sire breeds. The differences in daily gain and feed conversion by dam are highlighted by three groupings. The group with the highest gain and lowest feed per unit gain were the CH, CN, SN, and LN. The HA, SH, SA, and LH comprised the group with the lowest growth rate and the highest feed per unit gain. The CA and LA were in a mid grouping.

The dressing percent and grade distribution of the carcasses are in Table 4. The dressing percent was highest for the L terminal sire cross and lowest for the HA dam cross. A high percent of all carcasses graded A1. Animals were slaughtered on an age basis, not when finish was adequate. As a result, some

Table 3. Beginning and final weight, average daily gain, and feed conversion of specific breed cross cattle by breed

Breeds	Weight				Average daily gain				Feed/gain ratio	
	Beginning		Final		140 days		Final		140 days	Final
Sire	kg	lb	kg	lb	kg/d	lb/d	kg/d	lb/d		
C	253	557	503	1107	1.36	2.99	1.27	2.79	6.50	7.20
S	243	535	487	1071	1.32	2.90	1.22	2.68	6.53	7.21
L	237	521	466	1025	1.24	2.73	1.15	2.53	6.74	7.46
Chi	253	557	503	1107	1.34	2.95	1.25	2.75	6.51	7.21
Dam										
HA	225	495	455	1001	1.26	2.77	1.17	2.57	6.78	7.44
CH	237	521	482	1060	1.34	2.95	1.25	2.75	6.43	7.08
CA	241	530	483	1063	1.30	2.86	1.21	2.66	6.60	7.28
CN	250	550	490	1078	1.33	2.93	1.24	2.73	6.34	7.01
SH	245	539	478	1052	1.25	2.75	1.17	2.57	6.68	7.44
SA	246	541	480	1056	1.25	2.75	1.17	2.57	6.65	7.35
SN	253	557	496	1091	1.32	2.90	1.24	2.73	6.52	7.19
LH	237	521	471	1036	1.24	2.73	1.16	2.55	6.83	7.50
LA	237	521	476	1047	1.29	2.84	1.20	2.64	6.51	7.26
LN	239	526	477	1049	1.36	2.99	1.24	2.73	6.24	7.03

Table 4. Dressing percent and grades of specific breed cross cattle by breed

Breeds	Dressing Percentage	Carcass grades (%)			
		A1	A2	A3&A4	B1&C1
Sire					
C	60.5	81.0	14.5	1.4	3.1
S	60.2	83.3	13.6	0.9	2.2
L	61.6	78.3	18.7	1.5	1.5
Chi	61.4	92.4	5.2	0.0	2.4
Dam					
HA	60.1	72.0	26.5	1.5	0.0
CH	60.7	83.7	11.6	1.2	3.5
CA	61.3	84.9	11.3	0.0	3.8
CN	61.4	91.6	6.0	1.2	1.2
SH	60.9	86.7	9.7	1.8	1.8
SA	60.7	82.2	13.9	0.8	3.1
SN	61.1	87.1	11.2	0.9	0.8
LH	60.7	89.6	8.1	0.0	2.3
LA	61.0	87.1	9.7	0.0	3.2
LN	61.4	85.3	9.5	1.0	4.2

carcasses had insufficient finish to grade in the A category and some were overfinished grading A3 or A4. The majority of those grading B1 were under 450 kg (990 lb), but there were three animals which weighed over 550 kg (1210 lb) that graded B1. The Limousin terminal sire and the Hereford-Angus dam crosses produced a higher percent of A2s. The Chianina terminal sires produced the highest percent of A1 carcasses.

THE ANALYSIS

When purchasing feeder calves, how much can you afford to pay? It will depend on the expected price of finished cattle, the cost of feeding and maintaining the calves, and the expected weight gain. The excess of returns over the cost of gain can be applied to the purchase price of the calf. If calves can be purchased for less than the break-even price then a profit can be made on feeding the calves. The expected returns depend on the price of finished calves, the grade, and the market weight. Costs depend on feed prices, feed conversion, length of time on feed, facilities, and veterinary and medicine (including implants). The analysis determined the price that could be paid for each of the 1039 feeder calves under three methods of pricing the finished animal. The three pricing methods were liveweight, dressed carcass weight, and yield of lean.

Price and cost data used in the analysis were current market prices and Manitoba Agriculture Farm Business Management cost values. Liveweight price for A1 was $187.20/100kg ($85.10/cwt) and the carcass price was $320/100kg ($145.45/cwt). Grade discounts were based on the Montreal wholesale carlot prices. Wholesale prices for primal cuts were used to determine the producer prices for lean cuts. Since cattle can not be sold based on lean yield, producer prices for lean were derived from wholesale prices for specific cuts and the average yield of lean for these cuts. The lean cut prices were set to equate the value of an average carcass sold on a lean basis to that on a carcass basis. Feed costs were current costs for the diet in Table 2. Costs for bedding, veterinary, medicine, facilities, labour, and the interest rate were from The Beef Finishing Bulletin of Manitoba Agriculture.

RESULTS

The maximum price that could be paid for each steer calf, for the three pricing methods, was determined. The average prices by terminal sire and breed cross of dam were calculated and adjusted to the same initial weight on feed and the same slaughter age. These prices are reported in Table 5. Just looking at the terminal sire breeds. When pricing on a liveweight basis, the price that could be paid for C, S, and Chi feeder steers of the same weight was similar and higher than what could be paid for L. These results reflect the daily gain and feed conversion in Table 3. Daily gain and feed efficiency were lowest for the L terminal sire. Selling on a hot carcass basis, the Chi price was higher than the C, and both were higher than prices for the S and L, which were similar. The L and Chi did relatively better because of a higher dressing percentage. When selling lean meat, the price for Chi was higher than for the C and L, which were similar, which were higher than the S. The yield of lean was lowest for

the S and highest for the L. Regardless of the pricing method used for the finished steer, the price that could be paid for feeder calves was highest for Chi followed by the C. The method of pricing did effect the S and L cross calf prices with the L priced higher based on lean yield, compared with the other breeds. The S price was comparatively higher when based on liveweight.

The price that could be paid for a feeder calf, of the same weight, can also depend on the breed cross of the dam. Pricing on a liveweight basis resulted in three dam groupings which matched those of daily gain and feed conversion. The CH, CN, SN, and LN have the highest price and the HA, SH, SA, and LH the lowest price. Pricing on a hot carcass basis resulted in the highest price for CN, SN, and LN steer calves and the lowest for HA. Pricing on a lean basis resulted in the CN, and LN having the highest and HA the lowest price that could be paid for feeder calves of the same weight. The major effect of pricing method on the dam crosses was the HA was comparatively lower priced when pricing the finished steer by carcass or lean yield.

Table 5. Break-even feeder price by pricing method and breed

Breeds	Pricing method of finished steer					
	Liveweight		Hot carcass		Lean meat	
Sire	$/100kg	$/cwt	$/100kg	$/cwt	$/100kg	$/cwt
C	260	118	273	124	271	123
S	257	117	267	121	263	119
L	246	112	264	120	268	122
Chi	262	119	280	127	282	128
Dam						
HA	251	114	260	118	252	114
CH	260	118	275	125	275	125
CA	256	116	273	124	275	125
CN	261	119	280	127	281	127
SH	254	115	269	122	271	123
SA	254	115	269	122	271	123
SN	260	118	277	126	273	124
LH	254	115	267	121	270	122
LA	257	117	273	124	274	124
LN	262	119	281	128	280	127

The price premiums over the HA obtained in the analysis do not directly correspond to those observed in the market. This analysis would price Limousin cross calves lower and Simmental calves higher than what has been observed in the feeder calf market. Pricing on a lean basis reflected the market pricing better than pricing liveweight or carcass weight. This may indicate that the industry is taking lean yield into account.

The Simmental crosses did better in this analysis than would be expected based on feeder calf prices. There are four possible reasons. First, Simmental cross calves in this study were at most 50% Simmental. The higher the percent Simmental in the cross, the less the feeding industry is willing to pay.

Percentages greater than 50 are those that are being discounted the most. Secondly, this analysis used an all concentrate diet, while many feedlots use a silage-grain diet. (Corn silage in eastern Canada and corn and barley silage and haylage in western Canada). With the all concentrate diet fed in this study, the Simmental crosses were able to obtain adequate finish at lower weights. Thirdly, there is variation within the Simmental breed that may be greater than some other breeds, producing animals that are undesirable to feed. The "square-bodied" type Simmentals are generally not discounted, while the "pencil gutted", "horsey", and "dairy" types are not wanted by the feeding industry and will be purchased only if heavily discounted. This study may have had few of the undesirable types. And fourthly, many feeders have indicated health problems and bad legs occur too often, which was not a problem in this study.

The results indicate the Chianina cross calves would sell at premiums, which is contrary to what is occurring in the industry where Chianina crosses generally sell at a discount to all other breed crosses. In this study, the Chianina produced a good carcass and a very high percent of A1 grades. And as with the Simmental crosses, the diet could have been a major factor in the grades. A diet containing silage, or hay, may have resulted in more calves having inadequate finish and grading B1. This occurrence may even be more likely for the Chianina than the Simmental, given that fewer Chianina graded A2, A3, or A4.

FACTORS EFFECTING FEEDER STEER PRICES

To determine how the feeder calf price is effected by carcass and feed prices, feeder calf prices were calculated for a range of carcass and feed prices. These prices were then used to develop a table to indicate how much the feeder calf price would have to change to maintain the same profit level (Table 6). When the price of carcasses increases, the increased profits are passed on in higher feeder calf prices. Table 6 indicates that if the price of carcasses increases $1/100kg, the price that can be offered for a feeder steer can be increased $1.15/100kg. (A finished price increase of $1/cwt will result in a $1.15/cwt increase in the price that can be offered for feeder steers.) Note that the same value holds if using nonmetric or metric values. Higher feed prices also effect the price that can be paid for a feeder steer. An increase in the feed price of $.01/kg will reduce the feeder price $7.03/100kg. The effect of feed conversion could not be determined directly, but its value can be determined by using the effect of feed price on the feeder calf price. If feed efficiency were 10% higher, this would be equivalent to a 10% decline in the price of feed. This shows how prices of the finished product, feed, and feed efficiency effect the feeder steer price.

The weight of the calf when placed on feed and the gain potential of the calf will also effect the price that can be paid for the feeder calf. A calf weighing 1 kg more than other calves with the same preweaning and feeding gains would have a price $.74/100kg less. With feeder calf prices of $260/100kg ($118/cwt), the calf weight would have to be 35 kg (77 lb) heavier for the feeder price to decline by 10%. An additional .1kg/day gain prior to weaning would increase the feeder price $4.39/100kg. An additional .1 kg/day gain during the feeding period would increase the feeder price $13.95/100kg. These

two measures of gain reflect the growth potential of the calf and the feed efficiency. Calves with good growth potential will be more profitable to feed because of the increased growth, less time on feed, and generally better feed conversion. These last two factors which effect profits are unknown when the calf is purchased. As a result, other visual indicators are often used in an attempt to determine the expected performance of the calf. The breed cross of the calf is one such indicator, but you could create a lot of problems for yourself if only breed is used.

Table 6. The change in feeder steer prices caused by a change in the finished and feed prices, and by growth measures of weight, preweaning average daily gain, and average daily gain on feed

		Change in feeder prices	
		$/100kg	$/cwt
Carcass price	- ($/100kg)	1.15	-
	- ($/cwt)	-	1.15
Feed price	- ($.01/kg)	-7.03	-
	- ($.01/lb)	-	-7.03
Weight on feed	- (kg)	-0.74	-
	- (lb)	-	-0.15
Preweaning daily gain	- (.1kg)	4.39	-
	- (.1lb)	-	0.90
Daily gain on feed	- (.1kg)	13.95	-
	- (.1lb)	-	2.87

There were still some differences in breed crosses after taking feed costs, weight on feed, and gains into account. These were primarily due to differences in dressing percentage and yield of lean.

SUMMARY

There are economic reasons for feeder calf prices to differ by breed cross. The primary reason for the different prices are gain, feed efficiency, and carcass differences by breed cross. The price for a Hereford-Angus calf was lower than for crosses containing less British breeding. Prices for calves by dam crosses containing British and exotic breeding were similar, except the Hereford-Angus which was lower. Prices by terminal sire breed were dependent on the pricing method. Chianina and Charolais sired calves received the highest price over all pricing methods. Selling finished steers liveweight penalized high dressing percentage calves (Limousin). If calves could be priced on a lean basis, the profitability of crosses with high lean to bone ratios (Limousin) would increase relative to those with lower lean to bone ratios. The analysis indicated that returns were higher by marketing on a hot carcass basis, rather than liveweight. This result might not apply to all situations because the market spread between liveweight and carcass weight is based on a dressing percentage much lower than that of the steers in this study. The calves in the study were off feed and water for 14 hours prior to weighing before slaughter

and, therefore, had high dressing percentages. In deciding whether to market finished animals liveweight or on a hot carcass basis, check the price spread and your usual dressing percent and determine which has the highest returns.

Breed crosses which are noted for having to be a high weight for adequate finish, Simmental and Chianina, had adequate finish in this study at lower weights. The feeding of an all concentrate diet contributed to the calves having adequate finish at lower weights. The cost of grain compared to hay, silage, and haylage will be a major factor in the profitability of these crosses when compared with crosses that finish adequately on a roughage-grain diet. With present feed grain prices, feeding high concentrate diets will be profitable and the price discounts for calves that finish at higher weights should be less.

How might a grading system based on lean yield effect returns? Such a system would unlikely increase the returns to the industry, so do not view it as a means to increase returns to the feeding industry. Returns for specific breeds and breed crosses would be effected, depending on the lean yield. Returns would be adversely effected for the Hereford-Angus crosses, and to a lesser extent the crosses with at least 50% Simmental. Returns would be benefically effected for crosses with at least 50% Limousin. The remaining crosses would not be noticeably effected.

Good Management Can Reduce Grassland Weed Problems

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Managing grasslands to maintain a high level of production is the first and most important step in a weed control program. By nature, weeds are aggressive opportunists. They rapidly invade areas not occupied by other plants or occupied by plants low in vigor. Weeds such as leafy spurge are capable of invading grasslands in excellent condition. To avoid serious problems from leafy spurge and the knapweeds, the second step of a weed control program becomes vital: The grassland manager must maintain constant vigilance and be prepared to begin a control program at first sighting. One year's delay in initiating a control program can be very costly.

Prevention of Weed Problems

The most effective method for maintaining grasslands in a highly productive, and therefore a highly weed resistant condition, is to have a grazing management plan. This plan must be based on the resources available to the operator, and must take into consideration the past history and the current condition of the grassland. Preparation of a good plan requires some pencil pushing and a lot of careful observation and thought. But the benefits will be both profitable and gratifying.

A plan is of no use if it is not put to work. Implementing a grazing management plan does not necessarily mean increasing animal numbers. In many cases the first benefit will come from helping the grass catch up to livestock needs by improving forage production. Improved animal performance is generally the first return on investment from grassland improvement. After animal performance and grassland condition have reached their economic optimum, and only then, consider increasing animal numbers.

A special caution from the animal standpoint. Many stockmen have been selecting for larger animals. Larger animals require more forage, so without increasing numbers, stockmen have increased the grazing intensity on their grasslands without realizing it. The forage needs of the type, class, and size of animals must be part of the management plan.

Management Options

There are three types of grazing systems. Each system has several options or variations within it. Selection of a grazing system and the options that go with it depends upon the resources at hand, the ability and interest of the manager, and the objectives and goals to be achieved. Very briefly these types of grazing systems are:

1. Continuous; often called season-long. This system allows livestock access to all parts of the grassland throughout the grazing season. It is the simplest system, but it is also the easiest one to mismanage. It often leads to a deteriorated grassland condition and poor livestock performance.

2. Complementary; this system is usually the easiest to implement because it may not require any change in fencing of the grassland, particularly if it was previously in a continuous grazing system. It allows deferment of the major portion of the grassland by providing 30 to 45 days of grazing on seeded cool-season species in the spring. Depending upon soil and climate, either bromegrass or crested wheatgrass, or mixtures including alfalfa or other legumes, provide excellent complementary grazing. Options include seeding marginal cropland to grass or conversion of some of the present grassland to cool-season pasture by either interseeding or by plowing and seeding. Remember that grasses can survive on marginal cropland, but they will produce more on better soils, so the acres needed for a complementary spring pasture will be greater on poor soil, but putting grass on marginal land is a prudent long-term land management option. All of these decisions have long-term weed management implications, depending upon the historical and current weed problems.

3. Rotation; there are many variations of this system, but in general, it involves dividing the grassland into two or more smaller units and movement of the livestock between units according to a plan. The plan may involve only native range, or only seeded pastures, or a combination of seeded and native pastures, and even cropland residue. The important part of either the rotation or the complimentary system is the provision for a period of rest for the grassland during the growing season. Understanding the growth stages of the plants, and providing rest for the desirable species at a critical growth stage sometime during a two or three year cycle will usually lead to an improved grassland condition. If possible, plan to graze the less desirable plants at a time in which they may be palatable and of nutritional benefit to the livestock. This will help reduce their vigor and may be a practical weed control method. There is some indication that sheep can graze leafy spurge early in the season, and most livestock will graze annual weeds early in the weed's growth cycle.

Space does not allow elaboration on the many variations of the rotation grazing system. They include deferred-rotation, rest-rotation, switchback-rotation, and short duration-rotation. Details and research information can be obtained from pasture and range specialists in provinces and states in the Northern Great Plains.

Rescuing Your Grassland From Weeds

If weeds are already a problem, other steps will be necessary to rescue your grassland from them. If you are not using a grazing system, plan and implement one. Include in it special consideration for control of the major weed problems. If you have a system in use, study it carefully to determine why it failed to help control weeds or why it allowed weeds to invade. In addition to making changes in your grazing system, you may need to change your weed control program. Perhaps your land is not the source of seed for perpetuating the weed problem. This is the reason that coordinated weed control programs on a community basis are successful, particularly for the aggressive noxious weeds.

Use of herbicides in conjunction with a grazing system is often the easiest and fastest method of weed control. But it may also be the most expensive, and it may be a short-term solution. For the tough weeds like leafy spurge and the knapweeds, no patch is too small to spray, and over the long-term, no matter how expensive the herbicide, you can not afford not to spray. In time there will be help for control of these weeds by biological methods. But until the insects and

diseases become available for release, herbicides and good grassland management must be used.

Other management options are available to help control weeds. If the problem weed is palatable to another type or class of livestock, consider combination grazing by cattle and sheep, or switching from cattle to sheep or from sheep to cattle on the grasslands having the weed problem. Or switch from cow-calf to cow-calf plus yearlings. There is often an economic advantage to these combinations, above and beyond the weed control aspect.

Fertilizer, or fertilizer plus herbicide, has been shown to be an economically sound method for rejuvenation of either native or seeded grasslands. Research at the Melfort Research Station was reported to you at this Seminar in 1987. Long term research in North Dakota substantiates the usefulness of this technique. Renovation of old stands of bromegrass at Fargo and old stands of crested wheatgrass at Mandan was best accomplished by use of nitrogen fertilizer (Table 1). Total nitrogen in the soil under old stands of grass may be high, but it is not in a form available to the plants. The term "sod-bound" means that most of the soil nitrogen is incorporated in the roots, both dead and alive, and the plants cannot use it to produce new growth. When nitrogen fertilizer is applied, the response in growth of the grass plants is very large. The benefit from plowing and seeding back to grass was very short lived without adding the nitrogen fertilizer. Yields the first two years after establishment were higher than those of the check, but then the yields dropped back to the level of the check or lower.

Table 1. Dry matter yield of bromegrass at Fargo and crested wheatgrass at Mandan following various renovation techniques.

Treatment	Bromegrass	Crested wheatgrass
	Dry Matter Per Acre (lbs)	
	10-Year Average	12-Year Average
Check	2474	532
Cultivation[1]	1833	624
Cult. + 60 lbs P_2O_5	----	628
Cult. + 30 lbs N	----	1365
46 lbs P_2O_5	2533	----
30 lbs N	3482	1323
60 lbs N	----	1993
Manure (10 ton)	2704	----

[1] Plowed, fallowed, seeded.

Weeds are often a problem in old stands of seeded grass, and weeds also respond to nitrogen, so application of a herbicide is often needed as part of the renovation. Weeds are heavy users of soil water and they are strong competitors for space. Therefore control of the weeds allows the grass species to respond vigorously to nitrogen fertilization. Research at Mandan and at Williston, North Dakota, shows the additive effects of nitrogen and herbicide when pasture sage

(fringed sage) was the primary weed in the pasture (Table 2). Of particular interest is the fact that herbicide alone increased forage yield for a year or two after treatment, but then the pasture sage returned and grass production again decreased. Nitrogen fertilizer plus herbicide increased the vigor and production of the grass, which provided competition which kept the pasture sage from coming back. Nitrogen fertilizer alone increased both the grass and pasture sage growth, but the competition from the pasture sage reduced the grass production for this treatment. In a related study at Mandan, removal of the pasture sage with no other treatment, doubled the yield of crested wheatgrass. A study in progress at Sidney, Montana, indicates that annual weeds use from two to four inches of soil water during their spring and early summer growth period. Two to four inches of soil water saved through weed control will produce several hundred pounds of additional forage in a well-managed grassland.

Table 2. Dry matter yield of crested wheatgrass and native grassland using nitrogen and herbicide for renovation in North Dakota.

	Crested Wheatgrass-Mandan[1]			Native range-Williston[2]		
	lbs/acre		% Grass	lbs/acre		% Grass
Treatment	Grass	Weeds	Increase	Grass	Weeds	Increase
Check	1580	629	---	909	582	--
Herbicide only[3]	2455	167	55	1146	62	26
Fertilizer only	3494	730	121	1494	1223	64
Herb. + Fert[3]	4176	119	164	1745	52	92

[1] Four year average, 40 lbs N annually.
[2] Three year average, 75 lbs N spring of first year only.
[3] Two lbs/acre 2,4-D, first year only.

Some Specific Grassland Weed Problems

Space does not permit discussion of all weeds that can be problems in grassland. The following are examples of weeds in each of the three major growth types.

ANNUAL WEEDS: These plants reproduce by seed and may complete their life cycle in one year by germinating in the spring and maturing during the growing season, or they may be winter annuals that germinate in the fall, overwinter as a rosette and complete their life cycle during the next growing season. There are dozens of annual weeds, most of which can be controlled using herbicides or by mowing to prevent seed production. But of primary importance for control of annual weeds is improved grazing management to increase the vigor and competitiveness of the desirable plants. Examples of some annual weeds that can be costly in grasslands are:

1. Downy Brome (cheatgrass): An introduced species that has become naturalized in temperate regions of North America. An early maturing annual or winter annual. Best control is

prevention by above average management of grassland and elimination of small infestations which serve as a seed source. Mow early to prevent seed production, or thoroughly cultivate to eliminate all plants before seed formation. Fall application of atrazine at 1 pound/acre, then graze seven months later. This weed may not be a problem in southern Canada, but watch for it. As winter wheat culture moves north, and farming practices change, cheatgrass also moves north and invades grasslands in the winter wheat region.

2. Kochia (summer cypress, fireweed): Introduced as an ornamental from Europe and Asia. Escaped from gardens and flower beds, a prolific seed producer so it spread rapidly to roadsides, waste areas, fields and grasslands. A very palatable annual, it is readily eaten by livestock but can cause photosensitization in cattle and it was recently found to contain alkoloids capable of causing a toxic syndrome in livestock, often causing death. Sub-lethal dosage causes loss of thriftyness in animals. Invades disturbed areas in pastures, and open areas in overgrazed grasslands. Good grassland management provides the most practical control. Kochia seedling are weak competitors and seldom become established in well managed grasslands. Patches of kochia can be controlled by spraying with dicamba at 0.125 pound/acre + MCPA amine at 0.5 pound/acre on small plants.

BIENNIAL WEEDS: These plants reproduce by seed and the plant dies after seed is produced. As the term biennial indicates, these plants die after two years. The seeds germinate and a rosette type plant grows the first year. The second year, the plant flowers and produces seed, then dies. Some biennial weeds can be easily controlled by cultural methods, such as mowing to prevent seed production. Others are relatively easy to control with herbicides applied in the seedling or rosette year. Most of them are heavy seed producers and often the seed is relatively long-lived in the soil. Preventing seed production is an important part of long-term control programs. Like the annual weeds, biennial weeds take advantage of disturbance of the soil or of weakened, low vigor grass plants. Grazing systems that promote vigorous perennial grasses, reduce the probability of problems from biennial weeds. Examples of biennial weeds that can become very costly in grasslands are:

1. Gumweed (curly-top gumweed): An introduced species that is especially troublesome in the Northern Great Plains of North America. A very competitive species, it reduces the productiveness of useful grassland species primarily through competition for soil water. It has a sticky liquid in the flower head which causes livestock to avoid it and provides an easy characteristic for identification. Mowing in mid July and again in late August will prevent seed formation. An application of one pound/acre 2,4-D LV ester in early June will control gumweed. Grazing management to improve the vigor of the perennial forage species will greatly reduce the possibility of establishment of gumweed.

2. Spotted knapweed: An introduced species that is causing tremendous losses in grasslands of the northwestern United States and southwestern Canada. Montana now considers the

knapweeds to be their most costly weed problem. Learn to identify this one because it spreads rapidly and kills all other plants in a very short time. Mature plants are from six-inches to three feet tall, and do not have spines as do members of the thistle family. Flowers are dime-sized and purplish or white. The plants bloom from June to September. Mowing is ineffective for control of seed production because the plants will bloom on the short stumps left after mowing. It spreads by seed, often over long distances in weed infested hay or in pieces of plant material hung up on vehicles and machinery. It often gets its start in a new area in parking lots, feedyards or roadsides. There are two other species of knapweed that can be troublesome weeds: diffuse knapweed which closely resembles spotted knapweed in growth habit and control, and Russian knapweed which has a deep perennial root system and must be controlled much the same way as leafy spurge.

The best knapweed control is prevention. The plant is generally easy to control with herbicides, but if it ever goes to seed, the seed will provide new plants for many years. Herbicides are most effective on the rosettes formed the first growing season, but these are often hard to see and often the weed is not found until it blooms the second season. Picloram at 0.25 to 0.5 pounds (1 to 2 pints) per acre will control spotted knapweed when sprayed in the rosette or early bud stage, but repeat treatment is needed when seeds in the soil germinate. Progress is being made on biological control for the knapweeds.

PERENNIAL WEEDS: Perennial weeds are generally more difficult to control than are annual or biennial weeds due to their extensive root system. Some perennial weeds provide usable forage or browse and are not a problem unless they occupy an excessive amount of area. Western snowberry, wolf willow, and pasture sage are good examples. Other perennial weeds are very aggressive and provide little or no forage for livestock. Leafy spurge is the best example of the very aggressive type of weed. Examples of perennial grassland weeds are:

1. Pasture sage: Native to North America, it is found in most native ranges of the Northern Great Plains, as well as in old stands of seeded grass. It is generally not a problem, and is grazed in limited amount. A deep rooted plant, it survives drought better than do most grass plants and often increases following drought or heavy grazing. It often decreases after it has depleted the soil water supply in the third and fourth foot of soil, but will begin to increase again if the grass is not vigorous enough to provide competition to the seedlings. It can be controlled by use of 2,4-D and good management as described earlier in this paper.

2. Western snowberry (buckbrush): Native to North America, it is one of the most widespread shrubs in grasslands of the Northern Great Plains. It often occurs as an open stand in native range, providing protection and browse for livestock

and wildlife. It becomes a problem when it forms a dense thicket, particularly in drainage ways, and at the edge of wooded areas. An early June application of 2,4-D at 2 pounds/acre with a wetting agent will provide satisfactory control. This treatment will not eradicate the patch but it will open it up to allow grasses to grow in the patch. Good management of the grassland will generally limit the rate of increase of this shrub to an acceptable level.

3. Wolf willow (silverberry): Native to North America, it is commonly found on lighter soils, particularly where soil moisture is plentiful. It is a shrub or small tree, sometimes reaching heights of 15 feet. Leaves are silvery and rough on both sides. The plant has no thorns and often grows upright with no secondary branching. Livestock will graze it when it is in sparse stands, but avoid it in dense stands. Spreads rapidly by roots and seeds in heavily grazed areas. It can be controlled with 2,4-D at 1 pound/acre with a wetting agent, applied in early June. Retreatment for a year or two may be necessary to eliminate the patch.

4. Leafy spurge. Introduced to North America from Europe and Asia, it is an extremely aggressive noxious weed, spreading by roots and seeds. Of no use to cattle because they become sensitized to it and will avoid grazing palatable species growing in the spurge patches. Sheep will make some use of leafy spurge, but reports on success or failure as a sheep forage vary. Seed is carried by birds and in weedy hay. It is capable of becoming established in grasslands in the best of condition. Early detection of plants and spraying before the plants are more than two years old will generally kill it. Older plants are seldom killed by herbicide, but can be kept from producing seed with a diligent spray program. The most effective treatment is a tank mix of picloram at 0.25 to 0.5 pound/acre plus 2,4-D at 1 pound/acre applied at the time the true flowers are present. Annual retreatment is necessary for several years to maintain control at a level which will maintain the forage species at an economically useful level. With no treatment, leafy spurge will dominate the vegetation and render the area useless for feed or forage. Progress is being made on biological control for leafy spurge.

Summary

Total direct and indirect cost of weeds to North Dakota agriculture has been estimated to be nearly equal to the net return to agriculture in the state. I'm sure that the situation is not too different in Manitoba, depending upon how many acres of serious weeds you have -- such as leafy spurge. Losses in production are often subtle and difficult to measure, but in regions of limited precipitation, competition by weeds for soil water reduces production of useful plants. Many weeds contain toxic agents that may not be lethal to livestock but they can reduce animal performance. These losses are hard to evaluate.

Some weeds can be easily controlled or managed at an acceptable level. Pasture sage, gumsweed and kochia fall in this category. Others are next to impossible and expensive to control once established, so prevention is the best management for control of these. Leafy spurge and the knapweeds are prime examples of this type. Others are acceptable and perhaps even useful if they are managed to maintain a low level of incidence in the grassland. Western snowberry is a good example.

Good grazing management will help reduce weed problems in most cases, but some weeds, such as leafy spurge, will invade grassland in best as well as poorest condition. For these, other management strategies geared toward prevention must be used. For these weeds, no patch is too small to spray, and eternal vigilance is mandatory, unless you are willing to sell out to the weeds.

APPENDIX

A list of common names and scientific nomenclature for the plant species referred to in the text.

Common Name	Scientific Nomenclature
Western snowberry (buckbrush)	*Symphorcarpos occidentalis*
Cheatgrass (downy brome)	*Bromus secalinus*
Gumweed	*Grindelia squarrosa*
Marestail (horseweed)	*Conyza canadensis*
Leafy spurge	*Euphorbia esula*
Pasture sage (fringed sage)	*Artemisia frigida*
Wolf willow (silverberry)	*Elaeagnus commutata*
Spotted knapweed	*Centaurea maculosa*
Diffuse knapweed	*Centaurea diffusa*
Russian knapweed	*Centaurea repens*
Kochia (summer cypress), (fireweed)	*Kochia scoparia*
Bromegrass	*Bromus inermis*
Crested wheatgrass	*Agropyron desertorum* and *Agropyron cristatum*

HIGH TENSILE FENCING

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High tensile smooth wire fencing has been used in Australia and New Zealand for about 25 years and has also gained wide acceptance in British Columbia and Alberta. Drawing on the research and experience in these areas, Manitoba Agriculture in 1985 began to construct some fences with farmer cooperators to demonstrate the design and advantages of this type of fencing.

High tensile smooth wire has several advantages over barbed wire:

1. COST: close to half the cost of barbed wire per unit length.

2. HANDLING: easy to handle since there are no barbs to catch on vegetation or tangle with other wires while stringing.

3. ELASTICITY: since there are no barbs, behaves elastically along entire length, thus tolerates shock loads well.

4. SAFETY: safer both in handling and for livestock and wildlife.

5. STRETCHING: no prestretching required to obtain elasticity; easily tensioned with in-line tighteners.

6. REPAIRS AND MAINTENANCE: due to elasticity and high tensile strength, is not easily damaged by heavy snow loads or stock pressure.

This type of fencing is versatile. Various designs are used for horses, sheep, cattle, hogs, predators, and wildlife.

COMPONENTS

A high tensile smooth wire fence consists of a pair of anchors (brace assemblies) between which wires are strung, line posts to which the wires are loosely held with staples, and droppers which further stabilize the wire spacing.

Brace assemblies:

-provide the strength for the fence

-careful construction required

-single span suitable for up to six wires in firm soils.

-6" x 8' P.T. posts driven 50" deep

-horizontal top brace, P.T. 4" x 10' pegged with 3/8" rods

-diagonal brace wire tightened with twitch stick

- 500 m (1650') maximum spacing

Line posts:

-maintain wire spacing

-support weight of wire

-prevent overturning

-3"-4" x 6' P.T. posts driven 26" deep

-spaced up to 60' depending on terrain

Line wires:

-are the restraining element

-12½ gauge triple galvanized (Type III) steel wire

-spliced with compression sleeves rather than knots

-tensioned with in-line tighteners

-one tension spring per wire unless tension is relaxed each winter.

Staples:

-hold wires at correct spacing on posts

-2" (minimum 1 3/4") corrosion resistant (galvanized) with opposing slash cut points

-rotated away from slash cut

-never driven home

Droppers:

-maintain wire spacing between posts

-distribute stress over all line wires

-increase visibility

-should be inexpensive, easily attached, resistant to bending or breaking.

TOOLS

In addition to regular tools used in fencing (hammer, fencing pliers, post driver, saw, brace and bit) some special tools are required. These include:

-crimping tool for splicing with compression sleeves

-in-line tightener handle for setting wire tension

-tension tester - home-made using fish scale

-spinning jenny for stringing line wire if purchased in rolls; not required if wire is purchased on spools.

ELECTRIC FENCES

Even larger savings can often be obtained by constructing permanent electric fences. The additional cost of an energizer, insulators, etc. may be more than offset by:

-smaller brace posts

-smaller and fewer line posts

-fewer line wires

-fewer droppers

Electric fencing is the obvious choice for temporary fences and dividing fences for strip grazing.

Up to 50 miles of fence can be effectively electrified provided that the fence is properly constructed and a powerful electronic energizer is used.

DESIGN

Although fencing with smooth wire will be quicker and cheaper, it is only the best workmanship and materials that build a long life, maintenance-free fence. Fence designs for different applications are available in publications from Agriculture Canada, BC Ministry of Agriculture and Food, Alberta Agriculture, and from materials suppliers. These designs should be used. Relying on "innovator instinct" can lead to very unsatisfactory results.